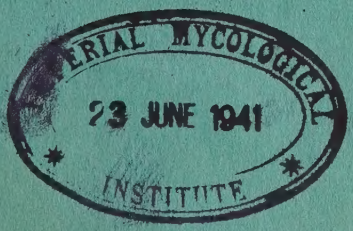
PAPERS

OF THE

MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

XXVI (1940)

PART I: BOTANY AND FORESTRY



MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

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PAPERS OF THE MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

EDITORS
EUGENE S. McCARTNEY
MISCHA TITIEV

VOLUME XXVI (1940)
PART I: BOTANY AND FORESTRY

"Pusilla res mundus est nisi in illo
quod quaerat omnis mundus habeat."
— SENECA, *Naturales Quaestiones*

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CONTENTS

BOTANY

PAGE

NOTES ON THE MICHIGAN FLORA. VIII. Oliver A. Farwell 3
ADDITIONS TO THE FLORA OF MICHIGAN. III. Clarence R. Hanes .. 21
A CONCLUDING LIST OF DESMIDS FROM ISLE ROYALE, MICHIGAN. Gerald W. Prescott 23
DISTRIBUTION OF THE RANUNCULACEAE IN MICHIGAN. Betty M. Robertson 31
NEW AND UNUSUAL AGARICS FROM MICHIGAN. II. Alexander H. Smith 61
NOTES ON THE MARINE ALGAE OF TEXAS. Wm. Randolph Taylor. 69
FLORA OF HACIENDA VISTA HERMOSA, NUEVO LEÓN. A MESOPHYTIC NONALKALINE HABITAT IN THE EASTERN SIERRA MADRE OF MEXICO. Stephen S. White 81
VEGETATION OF CERRO DE LA SILLA, NEAR MONTERREY, MEXICO. Stephen S. White 87
SEED GERMINATION AND SEEDLING ANATOMY OF SNAPDRAGON (*ANTIRRHINUM MAJUS* L.). Edward F. Woodcock 99

FORESTRY

SOME RESUPINATE POLYPORES FROM THE REGION OF THE GREAT LAKES. XII. Dow V. Baxter 107
GROWTH ON CUTOVER SPRUCE–FIR PULPWOOD LANDS IN NORTHERN MICHIGAN. Arthur B. Bowman 123
THE USE OF LOG GRADES IN APPRAISING LUMBER VALUES OF SELECTIVELY CUT NORTHERN HARDWOOD TIMBER. Willard S. Bromley 135
NATIONAL-FOREST LAND MANAGEMENT IN MICHIGAN. H. Basil Wales 143
THE GROWTH AND DEVELOPMENT OF A MIXED-CONIFER PLANTATION. Leigh J. Young 153

ILLUSTRATIONS

PLATES

BOTANY

FACING PAGE

PRESCOTT: Pls. I–II. Desmids from Isle Royale 30
SMITH: Pls. I–III. Agarics from Michigan 68
WHITE:
Pl. I. View of La Silla, Mexico, from Monterrey 98
Pl. II. Flora of Cerro de la Silla 98
WOODCOCK: Pls. I–II. Seedling anatomy of *Antirrhinum majus* L. .. 104

FORESTRY

BAXTER: Pls. I–VII. Resupinate polypores 122
YOUNG:
Pl. I. Wide crowns of Scotch pine and suppressed Norway spruce in adjacent rows 158
Pls. II–III. Red pine after pruning and before 158

FIGURES IN THE TEXT

FORESTRY

BOWMAN: PAGE
Figs. 1–3. Graphs showing merchantable volume of timber in stands in northern Michigan after cutting for various basal areas 124–126
Figs. 4–5. D.B.H. growth of all important species of trees found on spruce–fir cutover areas in northern Michigan 132

BOTANY

NOTES ON THE MICHIGAN FLORA. VIII

OLIVER A. FARWELL

THIS paper records the finding of plants that are new to Michigan and contains notes on rare or interesting species. Of the counties mentioned, Keweenaw and Houghton are in the north-central part of the Upper Peninsula; the others are some 450 miles farther south, in the southern part of the Lower Peninsula.

List of Species

Osmunda cinnamomea Linn. var. **sterilis,** var. nov. — Cinnamon fern. *Lamina supra sterili, infra fertili.* The fertile frond is more or less sterile, the fertile part occurring below, the sterile above; some of these sterile pinnules are crowded, more or less crisped, plaited or pinnatifid. Presumably similar to var. *frondosa* A. Gr., but in that variety the fertile part is uppermost, just the reverse of the arrangement here. Romulus, Wayne Co., no. 8674, June 3, 1930. Rare.

Ophioglossum vulgatum Linn. — Adder's tongue. The only time I have seen this plant in the field in forty years of botanizing in the Lower Peninsula. Romulus, Wayne Co., no. 8673, June 3, 1930.

Hippochaete laevigata (A. Br.) O. A. F. var. ramosa (A. A. E.) O. A. F. — The fertile stem sends out sterile branches at the base of the nodes in the upper half, or sometimes from near the base of the stem throughout. Algonac, St. Clair Co., no. 3685, June 21, 1914. Flat Rock, Wayne Co., no. 7946, June 8, 1927. Farmington, Oakland Co., no. 8625½, Oct. 8, 1929.

Picea brevifolia Peck. — Swamp spruce. As found on the Keweenaw Peninsula the swamp spruce is a dwarf tree rarely over ten feet high and growing only in peat bogs; fruit is seldom produced. It is readily recognized by its short, glaucous leaves. Keweenaw Co.: Cliff Mine, no. 42a, Aug., 1900; Eagle Harbor, no. 11732, June 27, 1938. Laurium, Houghton Co., no. 11496, Aug. 14, 1936.

JUNIPERUS COMMUNIS Linn. — Common juniper. The typical variety of the species, which is a tree; this is the only place I have seen it in Michigan. Tyrone, Livingston Co., no. 8677, June 10, 1930.

POTAMOGETON MICROSTACHYS Wolfg. (*P. alpinus* Balbis). — Fernald has recently shown that this name should replace *P. alpinus*. St. Clair River at Marine City, no. 6751, Aug. 29, 1923. Detroit River, no. 514a, Sept. 30, 1892.

Var. SUBELLIPTICUS Fernald. — Streams on the Keweenaw Peninsula, no. 514, Aug. 1, 1887.

ECHINOCHLOA CRUSGALLI (L.) Beauv. f. **zelayensis** (HBK.), comb. nov. (*Oplismenus zelayensis* HBK., *Nov. Gen. et Sp.*, 1 : 108. 1815). — Very similar to f. *mitis* (Ph.) O. A. F., from which it is difficult satisfactorily to distinguish it. Detroit, Wayne Co., no. 648a, Aug. 18, 1893. Oakland Co.: Orion, no. 648c, Aug. 29, 1895; Avon, no. 6850, Oct. 3, 1923. Marquette, Marquette Co., no. 648d, Aug., 1902.

PANICUM DICHOTOMIFLORUM Mx. var. GENICULATUM (Muhl.) Fern. — Although Fernald (*Rhodora*, 38 : 387–390. 1936) claims that *P. geniculatum* Muhl. (*Muhl. Cat.*, p. 8. 1813) is only a substitute name for *P. dichotomiflorum* Mx. (*Fl. Bor. Am.*, 1 : 48. 1903), yet the evidence he produces clearly shows otherwise, and indicates that it is a legitimate renaming of Walter's plant *P. milliaceum*? (*Fl. Carol.*, p. 72. 1788), which Walter had wrongly identified. Muhlenberg not only gave Walter's habitat and excluded that of Michaux's species, but also took his specific name from the description by Walter. Therefore Muhlenberg's species *must rest upon the description that gave rise to the specific name.* If Muhlenberg included both Walter's and Michaux's species in his *P. geniculatum* it merely shows that he did not differentiate between the species of Michaux and of Walter but that Walter's species giving rise to Muhlenberg's specific name *must stand as its type*. Furthermore, Fernald admits that Muhlenberg described the same plant as did Walter. Fernald's conclusions, nomenclatorily, are contrary to the facts. He attributes the varietal name *geniculatum* to Wood. That Wood was not familiar with the publications of Muhlenberg and of Elliot and that he did not get his varietal name *geniculatum* from them, even if he did not say so, is unthinkable. "Muhlenberg" should be the name enclosed in marks of parenthesis instead of "Wood." This variety is the only

form of the species that I have found in Michigan. Detroit, Wayne Co., no. 4101, Sept. 23, 1915, no. 4812, Nov. 15, 1917, and no. 11697, Sept. 9, 1937. Oxford, Oakland Co., no. 6416, Oct. 4, 1922. Lake Linden, Houghton Co., no. 12247, Oct. 6, 1939.

PANICUM STRICTUM Ph. var. **psilophyllum** (Fern.), comb. nov. (*P. depauperatum* Muhl. var. *psilophyllum* Fern., *Rhodora*, 23 : 193. 1921). — Frequent throughout Michigan. St. Clair Co.: Port Huron, no. 4970, June 20, 1918; Algonac, no. 5498, June 20, 1920. Portage Lake region, Washtenaw Co., no. 5850, June 12, 1921. Seven-Mile Point, Keweenaw Co., no. 11338, July 16, 1936.

PANICUM LANUGINOSUM Ell. var. FASCICULATUM (Torr.) Fern. subvar. **pilosum** (Torr.), comb. nov. (*P. nitidum* var. *pilosum* Torr., *Fl. N. and Mid. U. S.*, p. 148. 1824). — The variety and subvariety intergrade, and both are common throughout the state.

PANICUM LANUGINOSUM Ell. var. IMPLICATUM (Scribn.) Fern. subvar. **meridionale** (Ashe), comb. nov. (*P. meridionale* Ashe, *Journ. Elisha Mitchell Sci. Soc.*, 15 : 59. 1898). — The subvariety is less pubescent than the variety. Both are found throughout the state.

CHAETOCHLOA GLAUCA (L.) Scribn. var. **purpurea,** var. nov.[1] — *Setis purpureis.* Bristles purple. Widely distributed in southeastern Michigan. Wayne Co.: Detroit, no. 5661, Sept. 1, 1920, and no. 6467, Oct. 28, 1922; Redford, no. 7246, Oct. 8, 1924. La Salle, Monroe Co., no. 7167, Sept. 17, 1924. Bloomfield, Oakland Co., no. 7278, Oct. 19, 1924.

AGROSTIS SYLVATICA Huds. — Very good specimens were found, one in low swampy ground and the other in dry stamp sand. It is apparently a pathological form of *A. stolonifera* L. (*A. vulgaris* With.). Keweenaw Co.: Eagle Harbor, no. 11749, June 27, 1938; Cliff Mine, no. 12119, Aug. 26, 1939.

AMMOPHILA BREVILIGULATA Fernald. — Beal gives no citation for the Upper Peninsula in his *Michigan Flora*. Found on sand dunes and sand shores. Keweenaw Co.: Bete Grise Bay sands, no. 9287, Sept. 1, 1932; Sand Bay dunes, no. 11816, Aug. 29, 1938.

[1] CHAETOCHLOA GENICULATA (Lam.) Millsp. and Chase var. **purpurascens** (Ell.), comb. nov. (*Panicum glaucum* L. var. *purpurascens* Ell., *Bot. S. C. and Ga.*, 1 : 113. 1816). — In my herbarium is a sheet of this variety, the label for which has been lost. The spike is slender and has short, purple bristles. It probably came from South Carolina; it is not a Michigan plant.

Trisetum spicatum (L.) Richter. — Downy oat grass. The downy oat grass is found on rocky shores of Lake Superior. Keweenaw Co.: Hunter's Point, no. 11302, July 14, 1936; Hebard Park, no. 12003, July 31, 1939. Lake Linden, Houghton Co., no. 1825½, Aug., 1904.

Var. molle (Mx.) Beal. — On rocky shores of Lake Superior. I have not found the variety growing in association with the species, but intermediate forms occur. Keweenaw Co.: Copper Harbor, no. 658, Aug. 16, 1888, and no. 4004½, July 8, 1915; Eagle Harbor, no. 10027, Sept. 17, 1934.

Poa interior Rydb. — Forms dense caespitose clumps or stools. In sand at Agate Harbor, Keweenaw Co., no. 11642, June 27, 1937. The only place I have seen it in Michigan.

Poa nemoralis Linn. — Very similar to *P. interior* Rydb. Not at all frequent. Usually in rocky fields or woods. Keweenaw Co.: Cliff Mine, no. 848½, June 27, 1895; Copper Harbor, no. 850½, July 1, 1895. Bloomfield Center, Oakland Co., no. 4995, June 29, 1918.

Glyceria Fernaldii St. Johns. — A low procumbent grass in wet grounds near Laurium, Houghton Co., no. 11664, July 21, 1937. F. J. Hermann first found it here in 1936.

Fernald has presented revisions of *Festuca rubra* L. (*Rhodora*, 35 : 132–133. 1933) and *F. ovina* L. and its allies (*Rhodora*, 37 : 250–252. 1935). According to these revisions we have in Michigan the following varieties:

Festuca rubra Linn. — Found only once. Detroit, Wayne Co., no. 4509, July 6, 1917.

Var. commutata Gaud.[2] — Rochester, Oakland Co., no. 4504, June 28, 1917.

Var. subvillosa Mert. & Koch. — Ypsilanti, Washtenaw Co., no. 5746, May 19, 1921.

Festuca ovina L. — The typical variety of this species; Fernald restricts it to the range "Quebec to western New York and New Jersey."[3] It is found throughout Michigan. Cliff Mine, Keweenaw Co., no. 793, Aug. 18, 1890. Wayne Co.: Detroit, no. 793a, June 24, 1902, and no. 2020½, June 6, 1907; Livonia, no. 9407,

[2] Collected at Pocono, Pa., no. 8913, June 29, 1931.
[3] Collected at Pocono, Pa., no. 8914, June 29, 1931.

June 7, 1933. Ypsilanti, Washtenaw Co., no. 5747, May 15, 1921. Birmingham, Oakland Co., no. 8882, June 9, 1931.

Var. HISPIDULA Hackel. — In this variety the glumes and lemmas are hispid and bristly ciliate on the upper parts. Rochester, Oakland Co., no. 1722, July 4, 1901.

FESTUCA DURIUSCULA L. — Fernald regards this as a variety of *F. ovina* but it appears to be as distinct as *F. occidentalis* Hk. Its measurements should be increased as follows: height up to three and one-half feet; length of panicle up to nine inches and breadth of leaves up to one line. Trap Rock Valley, Houghton Co., no. 11727, June 19, 1938. Hebard Park, Keweenaw Co., no. 12005, July 21, 1939.

Var. **pubiculmis** (Hackel), comb. nov. (*Festuca ovina* L. var. *pubiculmis* Hackel). — In this variety at least the upper half of the culm is puberulent, and the panicle axis and branches are bristly. Algonac, St. Clair Co., no. 3641, May 24, 1914.

FESTUCA SAXIMONTANA Rydb. — This segregate of *F. ovina* is abundant on rocky shores and bluffs and may be found up to eighteen inches in height. Keweenaw Co.: Hunter's Point, no. 11303, July 14, 1936; West Bluff, no. 11315, July 14, 1936.

FESTUCA OCCIDENTALIS Hk. — This species is abundant in Keweenaw Co. in rocky woods and on rocky shores. It reaches a height of three and three-quarters feet, with a panicle often nine inches long. The stems are usually green but are sometimes red. Keweenaw Co.: Cliff Mine, no. 531, Aug. 5, 1887, and no. 531a, June 27, 1895; Copper Harbor, no. 849¼, July 1, 1895, no. 8493, July 24, 1929, and no. 8496 (red stems), July 24, 1929; Mt. Brockway, no. 10944, July 25, 1935; Hunter's Point, nos. 11270 and 11270a, July 14, 1936; near Lake Glazon, no. 11802, Aug. 29, 1938.

CLAUDIUM MARISCOIDES (Muhl.) Torr. — Twig rush. Beal gives this species for the Lower Peninsula only. I believe this is the first record for the Upper Peninsula. Houghton Co.: Rice Lake, southeast shore, no. 12048, July 28, 1939, and northwest shore, no. 12123, Aug. 30, 1939.

SCIRPUS CAESPITOSUS Linn. var. CALLOSUS Fernald. — Club rush. As I walked through a peat bog near Eagle Harbor my toes were continually catching underneath culms that were bent over and

rooting at the tip. *Eleocharis rostellata* Torr., I concluded. I collected some fruiting culms and reported the plant under that name, observing at the time that its spikes seemed rather small and more or less abortive; but I gave it no further study then. Recently the specimens again came under my observation, and I immediately saw that something was wrong. A close examination revealed that they were *S. caespitosus*. *E. rostellata* was probably there, but I failed to get any of it, even of the sterile culms rooting at the tip. Keweenaw Co.: in peat bogs at Eagle Harbor, no. 6631, June 29, 1923, and nos. 10008 and 10040, July 17, 1934; on rocky shores at Hunter's Point near Copper Harbor in dense, tough, caespitose clumps, no. 11276, July 14, 1936.

Carex arcta Boott. — Beal gives only one location in Michigan, that of my early collection in Keweenaw Co. I have the species now from Houghton Co. Borders of Black Pool, northwest of Cliff Mine, Keweenaw Co., no. 624, July 26, 1888. In low wet grounds near Jacobsville, Houghton Co., no. 12147, Aug. 30, 1939.

Carex pennsylvanica Lam. var. **livoniensis,** var. nov. — *Planta dioica.* Plant dioecious. In moist woods at Livonia, Wayne Co., no. 9368, April 25, 1933.

Carex prasina Wahl. — Sedge. In swampy grounds in valleys. Livonia, Wayne Co., no. 9454, July 18, 1933.

Xyris montana H. Ries. — Yellow-eyed grass. Beal gives no collections or collectors, merely citing it from *Gray's Manual,* Revised Edition, as a Michigan plant. Houghton Co.: shores of Lake Roland, no. 10253, Aug. 15, 1934; Rice Lake, southeast shore, no. 12042, July 28, 1939, and northwest shore, no. 12132, Aug. 30, 1939.

Tradescantia reflexa Raf. var. **eloiseana,** var. nov. — *Flore majore, 1.5 uncias in diam., petala obtusa, ovata, unam unciam longa.* Flowers larger, one and one-half inches across; petals broadly ovate, obtuse, one inch long, from royal purple to dark violet (Ridgway, 1912). The flowers are much larger and darker than the ordinary bluish purple (blue-violet, Ridgway, 1912) flowers of the typical variation of the species. Eloise, Wayne Co., no. 8902, June 16, 1931.

Juncus Gerardi Lois. — Black grass. In wet ditches. This is the first time it has been observed or collected in Michigan, in so far

as I am aware. Beal includes it in his *Michigan Flora*, not on specimens collected in Michigan, but on the basis of the following statement in *Gray's Manual*, Revised Edition: "Rare about the Great Lakes." The stem leaves number, actually, seven; the first three, at the base of the stem, are short-bladed and inconspicuous, but the next four are long-bladed and prominent, covering the stem nearly up to the inflorescence. Wayne, Wayne Co., no. 8897, June 16, 1931.

Juncus tenuis Willd. var. anthelatus Wieg. — This variety is infrequent. Moist ravines. Lake Linden, Houghton Co., no. 11788, Aug. 21, 1938.

Juncus Bogotensis HBK. var. **decipiens** (Buchn.), comb. nov. (*J. effusus* var. *decipiens* Buchn., *Engl. Bot. Jahrb.*, 12:229. 1890). — This variety is very scarce on the Keweenaw Peninsula. On the southeast shore of Rice Lake, Houghton Co., no. 12052, July 28, 1939. On the sandy shore of Bete Grise Bay, Keweenaw Co., no. 12110, Aug. 16, 1939.

Allium sibiricum L. — Chives. At an early date this was reported as *A. Schoenoprasum* from Eagle Harbor, Keweenaw Co. (no. 463, Aug. 30, 1886). Recently it has been found again in ravines. Lake Linden, Houghton Co., no. 11728, June 26, 1938.

Iris pseudacorus Linn. — Yellow iris or flag. In several inches of water on the shores of Middle River Rouge, where there is a clump with a dozen or more stalks four or five feet high. Northville, Wayne Co., no. 9116, June 22, 1932. Rare.

Corallorrhiza trifida Chat. var. **virescens** (Farr.), comb. nov. (*C. innata* var. *virescens* Farr.). — The flowers are yellowish green. Collected near Silver Mountain, Houghton Co., June 10, 1939, by Walter Mattson.

Betula alba L. — Canoe birch, paper birch. The typical variety of this species is frequent on the Keweenaw Peninsula, and the var. *papyrifera* (Marshal) Spach, which is cut for firewood, is very abundant. The typical species has been collected as follows: Houghton Co.: Lake Linden, no. 11576, Sept. 24, 1936; on the shores of Little Traverse Bay, no. 12039, July 28, 1939.

Var. cordifolia (Regel) Fernald. — This variety is scarce. Its leaves are cordate. West Bluff, Keweenaw Co., no. 12154, Sept. 5, 1939.

Polygonum Convolvulus L. var. **erectum,** var. nov. — *Planta*

minima erecta. Differs from the species only in being small and erect, under a foot in height. In waste grounds and on sand. Lake Linden, Houghton Co., no. 10115, July 28, 1934.

Polygonum cilinode Mx. var. erectum Peck. — On rocky grounds but not so abundant as the species type, which is plentiful even in swampy grounds, where it climbs over alders. Vicinity of Lake Glazon, Keweenaw Co., no. 12012, July 21, 1939. Houghton Co.: vicinity of Hungarian Falls, no. 10425, Aug. 30, 1934; Calumet, no. 11781, July 29, 1938.

Polygonum articulatum Linn. — Beach jointweed. Frequent in shore sand at Bete Grise Bay, Keweenaw Co., no. 9288, Sept. 1, 1932.

Kochia scoparia (Linn.) Schrad. — Summer cypress. River Rouge, Wayne Co., no. 9308, Sept. 14, 1932. Quite abundant. At this place and time we also observed var. *tricophylla* (Voss) Moellen. It has narrower, linear leaves, and the whole plant turns red in autumn. It is known as Mexican fire plant and is well established in southeast Michigan. The oldest varietal name is *culta*, and the variety should be known as *K. scoparia* (Linn.) Schrad. var. **culta** (Voss), comb. nov. (*Bassia scoparia* var. *culta* Voss). This variety was also found at Oakwood, now a part of Detroit, Wayne Co., no. 8811, Sept. 30, 1930.

Stellaria media (Linn.) Cyr. var. maxima (Schur) Guerke. — Chickweed. This species is very variable and may be found in all situations from rich garden soil to rocky or sandy hills and in rich woods; it is equally at home among native plants in primeval places and among naturalized weeds in cultivated grounds. Usually rated as an introduction, but I have no doubt that it is also native. Wayne Co.: Livonia, no. 8713, July 8, 1930; Northville, no. 9094, June 15, 1932.

Thalictrum dioicum Linn. — This is an early spring plant with greenish flowers, found on hillsides in copses, etc. Ypsilanti, Washtenaw Co., no. 1125, May 29, 1891. Belle Isle, in Detroit River, no. 1125a, June 20, 1893. Rochester, Oakland Co., no. 3626, May 17, 1914.

Thalictrum Cornuti Linn. (*T. canadense* Mill.; *T. confertum* Moench.; *T. corynellum* DC.; *T. polygamum* T. and G., not Muhl.). — As has been pointed out by the late E. L. Greene, there never was any real excuse for dropping the early Linnaean

name for one of much later date (not even the next in order and misapplied in the bargain). Beal included the species in his *Michigan Flora* as from the Keweenaw Peninsula on the strength of my early collection. I now find it for a second time, 450 miles to the south of the original station. Wayne, Wayne Co., no. 8900, June 6, 1931; original station, Cliff Mine, Keweenaw Co., no. 133, July 10, 1884. A new variety is recorded from New York.[4]

Thalictrum Cornuti Linn. is based on *T. canadense* Cornut, a species derived solely from Canada; *T. rugosa* Ait. is based on a North American specimen sent to Europe by Fothergill in 1774. Willdenow merely reproduced the description of Aiton; Pursh used Aiton's description but added to it. These names should be retained for the American species to which they were originally applied and should not be rejected in favor of the names of European species which in some way not now determinable were substituted for them.

THALICTRUM PURPURASCENS Linn. — Stem and flowers purplish; leaflet usually three-toothed, thin, oblong or lanceolate; margin even, puberulent beneath, *not glandular; inflorescence and fruit glabrous;* filaments filiform or slightly clavate, drooping in anthesis. Usually on low moist grounds. Cliff Mine, Keweenaw Co., no. 132, July 10, 1884. Ypsilanti, Washtenaw Co., no. 132a, June 23, 1891. Belle Isle in Detroit River, no. 132b, July 21, 1892. Parkedale, Oakland Co., no. 2781, June 30, 1912, and no. 3703, June 28, 1914. (I also have this from Peeks of Otter, Bedford Co., Va., collected by A. H. Curtiss in June, at an elevation of 4,000 ft. H. H. Rusby's no. 502, June, 1883, from Oak Creek, Ariz., is the same.)

Var. **rugosum** (Ait.), comb. nov. (*Thalictrum rugosum* Ait., Willd., Pursh; *T. carolinianum* Bosc. ex DC.; *T. dasycarpum* Fisch., Mey., and Ave-Lall.). — Similar, but it has *sparsely pubescent nonglandular fruit,* the ribs of which are sometimes branching. Belle Isle, in Detroit River, no. 1384a, June 27, 1893. Parkedale, Oakland Co., no. 3704, June 28, 1914. Detroit,

[4] Var. **stipitum,** var. nov. — *Fructu stipitato pubescenti.* In this variety the achenes are conspicuously stalked and beset with a few scattered hairs. Elmira, Chemung Co., N. Y., T. F. Lucy, no. 227, July 2, 1896. The range of this long-stipitate variety is said to be from New York to the Carolinas.

Wayne Co., George Suttie, June 6, 1891. (A. L. Johnson, Walkerville, Ont., June 1, 1892.)

Var. CERIFERUM C. F. Austin. (*Thalictrum pubescens* Ph.; *T. revolutum* DC.; *T. polygamum* Muhl., not T. and G., Sprengel). — Leaves thicker, margin revolute, underside puberulent *and glandular;* fruit pubescent, often glandular; glands sessile or stipitate. Cliff Mine, Keweenaw Co., no. 751, July 12, 1890. Detroit, Wayne Co., no. 1504a, June 9, 1896. (Also in the herbarium of Parke, Davis and Co., from Montclair, N. J., H. H. Rusby, no. 25A, July, 1879.)

JEFFERSONIA DIPHYLLA (Linn.) Pers. — Twin-leaf or rheumatism root. This rare member of the barberry family was found in Oakland Co. by Bach and Gladewitz in 1916. Livonia, Wayne Co., no. 9362, April 25 and May 17, 1933. Livonia is the only known station in Wayne County, and the plant is scarce; probably less than twenty individuals were observed.

BERBERIS THUNBERGII DC. — Japanese barberry. This is quite well and extensively established in rich woods in Rochester. The shrubs are over six feet high and fruit-bearing. Rochester, Oakland Co., no. 8729, Aug. 13, 1930.

SANGUINARIA CANADENSIS Linn. — Bloodroot. This is our most frequent species of bloodroot in southeast Michigan.

F. **incarnata,** f. nov. — *A specie incarnatis petalis differt.* Petals pink or flesh-colored, six to eleven lines long by two to four lines wide; flowers circular in outline. Melvindale, Wayne Co., no. 9377, May 2, and fruit May 23, 1931.

SANGUINARIA DILLENIANA Greene. — The flowers are quadrangular, of from seven to nine petals in two sizes and shapes; four large petals ovate, about fourteen lines long by seven or eight wide; smaller petals oblanceolate, about twelve lines long by three or four wide. Spread of flower when flattened out about two inches. Livonia, Wayne Co., no. 9363, April 25, and fruit May 17, 1931.

ARABIS LYRATA Linn. f. PARVISILIQUA Hopkins. — Washington, Macomb Co., no. 4158, May 25, 1916. Due West, Oakland Co., no. 7909, June 1, 1927. Keweenaw Co.: on bluffs at Cliff Mine, no. 154, Aug. 1, 1884; on rocky shores of Lake Superior, no. 154a, Sept. 12, 1887.

Var. INTERMEDIA (DC.) O. A. F. in *Mich. Acad. Sci., Ann. Rep.,* 19 : 256. 1917 (var. *kamchatica* Fischer in DC., *Syst.,*

2 : 231. 1821). — The varietal name *intermedia* has priority of position over *kamchatica*, since it precedes *kamchatica* on the same page in DC., *loc. cit.* Our plants, though far removed from the region of distribution as given by Hopkins, must nevertheless be placed here in accordance with the characters used by him. Rochester, Oakland Co., no. 1533½, July 4, 1896.

Arabis glabra (Linn.) Bernh. — This species and *A. Drummondii* may be readily confused in the young, flowering stage. Wayne Co.: Detroit, no. 1455, June 15, 1894, and no. 8687, June 17, 1930; Palmer Park, no. 1455a, June 16, 1894; Nankin, no. 7405, June 10, 1925; Livonia, no. 8420, June 4, 1929, and no. 9450, July 18, 1933. Keweenaw Co.: Cliff Mine, no. 1455c, June 28, 1895; Agate Harbor, no. 11641, June 27, 1937. Woodville, Newaygo Co., no. 5960, Aug. 4, 1921. Grand Ledge, Eaton Co., no. 6570, June 10, 1923. Tecumseh, Lenawee Co., no. 7978, June 21, 1927. Bloomfield, Oakland Co., no. 8883, June 9, 1931.

Var. furcatipilis Hopkins. — The pubescence of the stem base is of appressed branched hairs. Zoo Park, Oakland Co., no. 4208, June 17, 1916. South Rockwood, Monroe Co., no. 4943, June 16, 1918. Detroit, Wayne Co., no. 8688, June 17, 1930.

Arabis ovata (Ph.) Poir. — Ingham Co.: Williamston, no. 100b, May 28, 1905; East Lansing, no. 6526, June 9, 1923. Mackinac Island, Mackinac Co., no. 100a, June 20, 1895. Oakland Co.: Rochester, no. 2084½, June 16, 1909; Parkedale, no. 3426, June 8, 1913; Franklin, no. 5521, June 24, 1920. Copper Harbor, Keweenaw Co., no. 4001½, July 8, 1915. Detroit, Wayne Co., no. 8689, June 17, 1930.

Var. **glabrata** (T. and G.), comb. nov. (*Arabis hirsuta* var. *glabrata* T. and G., *Fl. N. Am.*, 1 : 80. 1838). — Cliff Mine, Keweenaw Co., no. 100, June 26, 1884, and no. 100c, July 3, 1895.

Arabis patula (Graham) Torrey at least as to name bringing synonym (*A. brachycarpa* (T. and G.) O. A. F. in *Asa Gray Bulletin*, 2 : 46. Oct. 1, 1894). — This combination is usually accredited to Britton in *Mem. Tor. Bot. Club*, 5 : 174. 1894; but no combination in that volume *can claim effective publication before Jan. 18, 1895*, the time of its general distribution. It is true that each fascicle was sent to editors for review as soon as printed and has the date of printing on the first page, but that does not constitute valid publication under the International

Rules. At the general distribution Parke, Davis and Co. and I received our copies Feb. 15, 1895, more than a month after the publication of the first number of the third volume of the *Asa Gray Bulletin*. I should, therefore, date publications of the latter as of Jan. 1, 1895, and of the former as of Jan. 18, 1895, in as much as it is known that a copy had reached the Pacific Coast as early as Jan. 25, 1895.

I had a long correspondence with C. A. Weatherby, of the Gray Herbarium, in regard to the valid date of publication of the fifth volume of the *Memoirs of the Torrey Botanical Club*, and after looking up all the known data pertaining to the matter he finally agreed with me that under the International Rules the valid date of publication of that volume and of all combinations made in it could not antedate Jan. 18, 1895, in the light of present knowledge. The *Asa Gray Bulletin* was published quarterly, and in the first nine issues only the month was given as date of issue, but the actual date of issue was always the first of the month of the issue. At my personal request the actual date of issue was placed under the title on the first page and continued to appear there in subsequent numbers as long as Miss C. G. DuBois continued as editor.

The mature fruiting pedicels of this species are said to be from erect to divaricately spreading. My experience with it indicates that this is true of the immature pedicels only, and that the mature pedicels are deflexed. Keweenaw Co.: Cliff Mine, no. 55, Aug. 20, 1883, no. 156, Aug. 1, 1884, and no. 11361, July 16, 1936; Eagle River, no. 5971a, Aug. 16, 1921; West Bluff, no. 10938, July 25, 1935.

Var. **stenocarpa** (Hopkins), comb. nov. (*Arabis divaricarpa* var. *stenocarpa* Hopkins, *Rhodora*, 39 : 133. 1937). — Scarce. Mt. Brockway, Keweenaw Co., no. 11968, June 23, 1938.

Arabis Drummondii A. Gr.[5] — Pedicels and fruit erect; no stellate pubescence. Keweenaw Co.: Cliff Mine, no. 55a, Aug. 20, 1883; Copper Harbor, no. 5966½, Aug. 16, 1921; Eagle Harbor, no. 10937, July 25, 1935.

[5] In the herbarium of Parke, Davis and Co. there is a specimen from Cape May, N. J., collected by A. Commons of Faulkland, Del., July 20, 1881, and distributed as *Arabis* (without specific name); also specimens from Minneapolis, Minn., G. B. Aiton, May, 1891, and from Colorado (without place), Thomas Hogg, July, 1872.

Var. PRATINCOLA (Greene) Hopkins. — The radical leaves are pubescent, with branched hairs. Hunter's Point, Keweenaw Co., no. 11274, July 14, 1936.

ARABIS HOLBOELLII Hornem. — Infrequent. West Bluff, Keweenaw Co., no. 11942, May 30, 1939.

ARABIS RETROFRACTA Graham. — Rocky grounds. Keweenaw Co.: West Bluff, no. 11959, June 23, 1939; Hebard Park, no. 11977, June 23, 1939.

ARABIS VIRIDIS Harger var. HETEROPHYLLA (O. A. F.) O. A. F. (*A. laevigata* var. *heterophylla* O. A. F., *Mich. Acad. Sci., Ann. Rep.*, 19 : 248. 1917; *A. viridis* var. *Deamii* Hopkins, *Rhodora*, 39 : 157. 1937). — Other collections are as follows: Oakland Co.: Parkedale, no. 2642, June 9, 1912, no. 2790, June 30, 1912, and no. 6951, July 2, 1924; Temperance, no. 7996, July 13, 1927. Wayne Co.: Nankin, no. 7405, June 10, 1925; Livonia, no. 8420, June 11, 1929.

SPIRAEA LATIFOLIA (Ait.) Bork. — Rare. On shores of Lac La Belle, Keweenaw Co., no. 12102, Aug. 16, 1939.

Var. SEPTENTRIONALIS Fern. — On shores and low wet ground. First time recorded for Michigan. Houghton Co.: Little Traverse Bay, no. 12029, July 28, 1939; Rice Lake region, no. 12050, July 28, 1939.

LATHYRUS PRATENSIS Linn. — Yellow pea. The flowers are bright golden yellow, with as many as thirteen in a raceme. In fields at Inkster, Wayne Co., no. 8905, June 16, 1932.

LATHYRUS TUBEROSUS Linn. — Bank of roadbed of the Michigan Central Railroad. Washtenaw Co.: Scio, no. 8705, June 24, 1930; Wiard, no. 8969, Aug. 4, 1932. Wayne Co.: Denton, no. 8958, July 21, 1932; Inkster, no. 8976, Aug. 11, 1932; Dearborn, no. 8990, Aug. 11, 1932.

SOJA MAX (Linn.) Piper. — Soy bean. Along a fence near an elevator in Dearborn, Wayne Co., no. 8986, flower Aug. 11 and fruit Sept. 29, 1932. The lower part of the plant is erect and bushy, but the upper parts are vinelike.

GERANIUM SANGUINEUM Linn. — Bloody cranesbill. Found in a grassy field and on roadside borders in the vicinity of Bloomfield Village, Oakland Co., no. 8884, June 9, 1932.

TRIBULUS TERRESTRIS Linn. — Caltrop. Railway roadsides. Dearborn, Wayne Co., no. 8987, Aug. 11, 1932.

EUPHORBIA PSEUDONUTANS Thell. (*E. hypericifolia* Mx., Ell., A. Gr., and most American authors, not Linn.; *E. nutans*, American authors, not Lag.; *E. Preslii*, American authors, not Guss.). — The plant commonly known in this country as *E. Preslii*, but not the species of Gussoni, which is the same as *E. nutans* Lag. of Mexico, according to Thellung. In shady places the leaves are broad and short, ovate; in sunny spots, long and narrow, oblong. On waysides mainly but also on borders of streams and in fields. Wayne Co.: Ecorse, no. 8832, Oct. 7 and 28, 1930; Taylor, no. 8837, Oct. 7, 1930; Wayne, no. 8931, July 14, 1931; River Rouge, nos. 9334 and 9335, Sept. 14, 1932. Wiard, Washtenaw Co. no. 8968, Aug. 4, 1931.

Var. HIRSUTA (Torr.) O. A. F. (*Euphorbia hirsuta* (Torr.) Wieg.; *E. Rafinesquii* Greene). — In similar situations but more frequent in fields and pastures than the species proper. Wayne Co.: Wayne, no. 8932, July 14, 1931; Inkster, no. 8984, Aug. 11, 1931.

EUPHORBIA GLYPTOSPERMA Engelm. — In sand and cinders. Inkster, Wayne Co., no. 8973, Aug. 11, 1931.

ILEX VERTICILLATA (L.) A. Gr. var. CYCLOPHYLLA Robinson. — Scarce; in swampy lands. Shores of Rice Lake, Houghton Co., no. 12171½, Sept. 19, 1939.

Var. TENUIFOLIA (Torr.) Wats. — The most frequent variety of this species to be found in the Copper Country. Generally called "Michigan holly." Northwest of Cliff Mine, Keweenaw Co., no. 622, July 26, 1888. Houghton Co.: Lake Roland, no. 10228, Aug. 15, 1934; shores of Torch Lake, no. 11148, Nov. 5, 1935; Electric Park, no. 11631, June 22, 1937; Rice Lake region, no. 12171, Sept. 19, 1939.

RHAMNUS CATHARTICA Linn. — Frangula, buckthorn. In swampy woods at Livonia, the first and only occurrence known in Wayne Co., though the plant was found several years ago in Oakland Co. Trees fifteen to twenty feet in height. Livonia, Wayne Co., no. 9448, July 11, 1933.

SIDA SPINOSA Linn. — A small waif along railroad. Taylor, Wayne Co., no. 8835, Oct. 7, 1930.

SIDA HERMAPHRODITA (Linn.) Rusby. — Virginia mallow. In low moist grounds, attaining a height of seven or eight feet. Sheldon, Wayne Co., no. 8941, July 14, 1931.

Malva borealis Wallm. (*M. pusilla* Sm.). — On roadsides and in waste places, where it has much the appearance of the common low mallow (*M. rotundifolia* Linn.), no. 9008, with which it is associated. It could be distinguished from the latter only by its prominently rugosely reticulated fruits. Dearborn, Wayne Co., no. 9002, Sept. 29, 1931.

Viola labradorica Schrank. — In crevices of rocks on shores of lakes. Keweenaw Co.: Eagle Harbor, no. 9743, June 20, 1934; Hunter's Point, no. 11285, July 14, 1936; Hebard Park, no. 11974, June 23, 1939. Misery Bay, Ontonagon Co., no. 10707, May 19, 1935.

Petroselinum hortense Hoffm. — Parsley. The common parsley is found as an escape to waste grounds. Beal does not list it. Houghton Co.: shores of Torch Lake, no. 11416, July 24, 1936; Lake Linden, no. 12228, Sept. 29, 1939.

Pyrola chlorantha Swz. — Shinleaf. The typical shinleaf is very scarce. It is found in rich moist woods. Eagle Harbor, Keweenaw Co., no. 11868, Oct. 6, 1938.

Var. paucifolia Fern. — This variety is not much more frequent than the typical one. Cliff Mine, Keweenaw Co., no. 304, Aug. 6, 1885. Lake Linden, Houghton Co., no. 10090, July 26, 1934.

Epigaea repens L. — Mayflower. Fernald (*Rhodora*, 41 : 446. 1939) has restricted the specific type to the southern plant with scabrous leaves. The northern plant with smoothish leaves he calls *E. repens* L. var. *glabrifolia* Fernald. This variety has white flowers and is commonly found under evergreens but sometimes occurs in the open, in fields or on hillsides under deciduous trees. Occasionally it flowers in the autumn. Throughout Michigan. Cliff Mine, Keweenaw Co., no. 10, June 12, 1883. Vicinity of Lake Linden, Houghton Co., no. 9612, May 11, 1934, no. 10677, Nov. 21, 1934, and no. 11934, May 18, 1939. Oxford, Oakland Co., on wooded hillsides, no. 4450½, May 20, 1917, and in open fields along roadsides, no. 5219, April 27, 1919.

Var. glabrifolia Fern. f. **rosea**, f. nov. — *Floribus roseis.* Flowers are pale rose or pink. I have never seen the pink and the white flowers on the same plant. A good color form. Lake Linden, Houghton Co., no. 11932, May 18, 1939.

Vaccinium ovalifolium Sm. — Bilberry. The bilberry is frequent

in woods but is not nearly so abundant as the common huckleberry (*V. membranaceum* Dougl.). Lake Linden, Houghton Co., no. 9697, June 7, 1934. On the Gratiot Range, Keweenaw Co., no. 12075, Aug. 8, 1939.

Convolvulus sepium Linn. var. fraterniflorus Mack. & Bush. — On railroad banks. There are often three peduncles from the same axil, usually two, and sometimes only one. Taylor, Wayne Co., no. 8836, Oct. 7, 1930. Frequent.

Lycopus rubellus Moench. var. arkansanus (Fresenius) Benner (*L. arkansanus* Fresen.). — Plant puberulent. Wayne, Wayne Co., no. 7151, Sept. 10, 1924.

Physalis ixocarpa Brot. — Strawberry tomato. In borders of brush. Dearborn, Wayne Co., no. 8982, Aug. 11, 1931.

Nicandra Physalodes (L.) Pers. — Apple of Peru. The apple of Peru is not listed by Beal. It is an escape to waste grounds. On shores of Torch Lake, Houghton Co., no. 12226, Sept. 28, 1939.

Pentstemon laevigatus Sol. — Beard tongue. Flowers gradually enlarged upward, small, white with violet veins; stems glabrous and more or less shining. Wayne Co.: Beach Road (Bach and Gladewitz, July 6, 1930), no. 8723, Aug. 5, 1930; Mack Woods, Detroit, no. 2036, Aug. 3, 1907. Scarce in southeastern Michigan.

Var. Digitalis (Sweet) A. Gr. (*Chelone Digitalis* Sweet). — Flowers much larger than those of species proper, abruptly dilated from near the base; stems glabrous and shining. Nine-Mile Road, Oakland Co., no. 1916a, Aug. 6, 1910. Algonac, St. Clair Co., no. 4229, June 22, 1916. Monroe, Monroe Co., no. 5822, June 9, 1921. Washington, Macomb Co., no. 5897, June 21, 1921. Wayne Co.: Detroit, no. 8685, June 17, 1930; noted at Livonia, July 8, 1930.

Var. **calycosus** (Small), comb. nov. (*Pentstemon calycosus* Small). — The internodes of the lower part of the stem are noticeably puberulent, and the calyx lobes are very narrow and long, often five lines long; leaves thinner, broader at base and clasping; otherwise like var. *Digitalis*. The color of the flower, white with violet veins, is much alike in all three varieties as found here. Pennell thinks my plant may be a hybrid between *P. Digitalis* and *P. calycosus* because the anthers are slightly pubescent. *Gray's New Manual* disposes of the matter by making the two synonymous. I think that on account of the puberulent

stem and elongated calyx lobes it may be well to maintain *calycosus* as a variety parallel with *Digitalis*. Belle Isle in Detroit River, no. 1916, June 20, 1905.

Veronica Anagallis-aquatica Linn. var. **terrea,** var. nov. — *Planta terrestris. A typica specie sepalis acutis vel obtusis, capsula orbiculata vel ovata, stylo longiore differt.* Plant slender, smaller in all its parts, less fleshy than species; terrestrial; in moist sand; one and one-half feet or less high, simple or branched throughout, glabrous except for a trace of short-stalked glands on some of the pedicels, which are two and one-half lines long in flowering and a line longer in fruiting stage; sepals acute or obtuse; capsule orbicular or ovoid (three lines long), emarginate; style three-quarters line to one and one-quarter lines long. Seems to be intermediate between *V. Anagallis-aquatica* and *V. catenata* var. *glandulosa*, containing characters of each but with a longer style than either. In Europe there is a *V. Anagallis* f. *terrestris* Ascherson growing in similar situations, but that is said to be simple. It may be the same as this. I have seen no specimens of it. Sandy banks of Middle River Rouge and on old wood roads at Northville, Wayne Co., no. 9105, June 22 and July 13, 1932.

Plantago Psyllium Linn. — Fleaweed. Two stations were found, with about six plants in all. Detroit, Wayne Co., no. 9350, Sept. 15, 1932.

Houstonia purpurea Linn. var. calycosa A. Gr. (*H. lanceolata* (Poir.) Britt.). — Bluets. Our first acquaintance with the variety. Gladewitz found it here in 1931 and referred it to var. *longifolia* (Gaertn.) A. Gr. It has narrow or ovate-lanceolate leaves. Not included by Beal in his *Michigan Flora* nor in his Supplement. In so far as I am aware this is the first report from Michigan. Plentiful in low grounds in Redford Township, Wayne Co., no. 9196, July 20, 1932.

Solidago bicolor L. var. paniculata O. A. F. — Described from Algonac specimens, but also found on the Keweenaw Peninsula, and in both instances within the influences of the shore waters and spray. Vicinity of Esrey Park, Keweenaw Co., no. 12222, Sept. 25, 1939.

Solidago bicolor L. var. spathulata O. A. F. — Another Keweenaw station was found for this variety. Vicinity of Esrey Park, Keweenaw Co., no. 12221, Sept. 25, 1939.

Solidago rigidiuscula (T. and G.) Porter. — This goldenrod is not listed by Beal. Not frequent. Near Hebard Park, Keweenaw Co., no. 12158, Sept. 5, 1939.

Solidago Randii (Porter) Britt. — On dry rocky grounds. Not listed by Beal. Keweenaw Co.: Eagle Harbor, nos. 11754 and 11756, June 27, 1938, and no. 12211, Sept. 25, 1939; near Esrey Park, no. 12217, Sept. 25, 1939.

Var. monticola (Porter) Fern. — Same situations as, and passing into, the typical variety. Not listed by Beal. Near Eagle Harbor, Keweenaw Co., no. 12212, Sept. 25, 1939.

Anaphalis occidentalis (Greene) Heller. — Not listed by Beal. Near Eagle Harbor, Keweenaw Co., no. 11867, Oct. 6, 1938, and no. 12213, Sept. 25, 1939.

Rudbeckia triloba L. — Brown-eyed Susan. Found on ballast ground, so may be an escape from cultivation. On shores of Torch Lake, Houghton Co., no. 12229, Sept. 28, 1939.

Anthemis tinctoria Linn. — An escape from cultivation. Plentiful near the Osceola swamp on waste ground near Calumet, Houghton Co., no. 11675, July 27, 1937.

Artemisia caudata Mx. — Wild wormwood. This species has been found on the Keweenaw Peninsula, thus extending its Michigan range far to the north and throughout the state. The manuals call it an annual or biennial, but in Michigan the species is certainly a perennial. Usually found in the yellow sand of the lake shores. Bete Grise Bay, Keweenaw Co., no. 10946, July 25, 1935. Little Traverse Bay, Houghton Co., no. 12026, July 28, 1939.

Sonchus uliginosus Bieb. — This species of sow thistle seems to have spread throughout the state. Houghton Co.: Calumet, no. 11683, Aug. 10, 1937; Lake Linden, no. 11987, July 17, 1939.

Arnica Whitneyi Fernald. — A new station for this plant was found between Eagle Harbor and Copper Harbor at Hebard Park. On a visit in late June to Copper Harbor cemetery, where I collected it in 1884, I found it still there and in considerable quantity. The local inhabitants call it "wild sunflower." Keweenaw Co.: Hebard Park, no. 11645, June 27, 1937; Copper Harbor cemetery, no. 11647, June 27, 1937.

Lake Linden, Houghton County
Michigan

ADDITIONS TO THE FLORA OF MICHIGAN. III

CLARENCE R. HANES

THE species listed in this paper represent collections made in Kalamazoo County during the year 1939 by Mrs. Florence N. Hanes and the writer. Specimens have been deposited in the herbaria of the University of Michigan, the Academy of Natural Sciences of Philadelphia, the Bailey Hortorium, the University of Oklahoma, and the National Herbarium. The identification of the plants has been confirmed at these institutions.

All species marked with an asterisk are new to Michigan records, so far as can be determined.

List of Species

*Eragrostis diffusa Buckl. — In a street in Schoolcraft, July 22, 1939, no. 709. The range of this grass is southern United States.

*Carex Frankii Kunth. — In a low open wood in the east-central part of Section 33, Climax Township, July 7, 1939, no. 429. It is unusual to find this sedge in Kalamazoo County, since its range is south of Michigan. According to Dr. F. J. Hermann, it has not been reported for the two northern tiers of counties of Indiana. Plants quite closely associated with it were *Carex crinita, Carex intumescens, Scirpus lineatus,* and *Penstemon Digitalis.*

Ranunculus hispidus Michx. var. falsus Fernald. — In an oak woodland in the north-central part of Section 5, Climax Township, May 15, 1939, no. 19. The variety prefers drier soil than the species. Apparently there have been no recent collections of this plant in Michigan. Miss Betty Robertson, of the University of Michigan, found herbarium specimens collected by Dr. R. M. Gibbs near Kalamazoo in May, 1874; by L. J. Cole near East Lansing in May, 1895; and by H. C. Sheels near Grand Rapids in May, 1895.

Arabis viridis Harger. — On sandy border of thin woods, one-half mile southeast of Hampton Lake, June 26, 1939, no. 1919. The

range map of Dr. Milton Hopkins [1] gives two main sections of the United States where this species of Arabis is found: (1) New York and New England and (2) Missouri and the area southwest. The lone previous Michigan record is from near Muskegon. In Kalamazoo County it has been collected at one station in Texas Township and at three in Portage Township.

Rubus Wheeleri Bailey. — In a swampy meadow, bordered by tamarack, one-fourth mile northwest of Hampton Lake, July 20, 1939, no. 629. This Michigan endemic was first collected in 1891 by Dr. L. H. Bailey in a tamarack swamp near Lansing. Soon afterward the station was cleared and drained. In the early 1930's it was again found near Lansing, by Dr. Bailey and others, but this second location also has been destroyed. The Hampton Lake specimen is the only plant of this species Dr. Bailey has seen other than those found near Lansing.

*Trichostema dichotomum L. — In sandy sterile soil on border of woods, near the northern edge of Section 7, Oshtemo Township, Sept. 19, 1939, no. 1739. This would appear to be a plant restricted mostly to the Atlantic Coastal Plain and, therefore, may be adventive in Michigan. Still, Kalamazoo County has some twenty of the so-called Atlantic Coastal Plain species that are found around the southern end of Lake Michigan and in the extreme southwestern portion of our state. The station where *T. dichotomum* was collected is near a section of Kalamazoo County where several other Atlantic Coastal Plain species occur.

Gratiola neglecta Torr. (*G. virginiana* of *Gray's Manual*, Seventh Edition). — On the muddy border of an old creek bed, in the central part of Section 31, Wakeshma Township, Aug. 1, 1939, no. 949. Collected with *Lindernia dubia* var. *major*. Apparently no reports of this species from Michigan have been made since Winchell's *Catalogue* [2] appeared. Dr. Francis W. Pennell, of the Academy of Natural Sciences of Philadelphia, who checked this plant, had previously seen no specimen from Michigan.

Schoolcraft, Michigan

[1] "Arabis in Eastern and Central North America," *Rhodora*, 39: 157. 1937.

[2] Winchell, N. H., "Catalogue of Phaenogamous and Acrogenous Plants Found Growing Wild in the Lower Peninsula of Michigan and the Islands at the Head of Lake Huron," *First Biennial Report of the Geological Survey of Michigan* [for 1860], pp. 245–330. 1861.

A CONCLUDING LIST OF DESMIDS FROM ISLE ROYALE, MICHIGAN

GERALD W. PRESCOTT

ISLE ROYALE in northern Michigan lies within what might be termed the North Temperate desmid belt. In this latitude of North America strong glaciation has resulted in many lakes and bogs which are favorable to the production of a rich desmid flora. With a few exceptions, however, the algae collections [1] which I have examined from this island have proved to be nontypical of desmid habitats in the surrounding area in respect to number of individuals. The brevity of the present list of species and of those lists previously published (7, 8, 9) is explained by the fact that not many of the Isle Royale collections in which desmids appear were taken with special attempts to obtain these plants. It is well known that particular techniques are required in gathering representative samples of desmids. As I pointed out (9), plankton species are conspicuously absent because tow collections were not made in the Isle Royale survey. There is every reason to believe that a rich and interesting flora awaits the special collector of desmids on this island, and no doubt future studies will add many species to those already reported.

My unpublished observations of Wisconsin desmids indicate a greater similarity between the flora of that state and of Isle Royale than was previously thought to exist (7). The desmids of the island, as might be expected, are much the same as those of Canada, Newfoundland, and, in general, of New England. When the desmid records for Michigan are compared with those for Massachusetts, however, only thirty-one per cent of the species are found to be common to both states (3). This is in keeping with the fact, which seems to be well established at present, that many species of desmids in the flora of the Atlantic coastal plain are limited to that region

[1] These samples were collected in the biological survey of Isle Royale conducted by the University of Michigan and authorized by the Fifty-fifth Legislature of the State of Michigan.

in North America. This is also true for the central part of the continent but for a much smaller number of species.

The 221 species and varieties from Isle Royale are distributed among the following genera:

Cylindrocystis	2	Arthrodesmus	3
Spirotaenia	1	Xanthidium	7
Netrium	2	Staurastrum	61
Penium	2	Euastrum	23
Closterium	22	Micrasterias	19
Spinoclosterium	1	Desmidium	5
Pleurotaenium	4	Hyalotheca	2
Tetmemorus	2	Gymnozyga	1
Cosmarium	64		

I wish to express my appreciation to the American Association for the Advancement of Science for a grant in aid which facilitated the preparation of an iconograph used in this study.

List of Species

Cylindrocystis Brebissonii Menegh.; Krieger, *Die Desmidiaceen*, Teil 1, Lief. 1 : 207, Pl. 6, Figs. 4–7. 1933.

Length 35.1 μ, width 15.6 μ. Pl. II, Fig. 14. Moose Lake.

Spirotaenia condensata De Bréb.; Krieger, *Die Desmidiaceen*, Teil 1, Lief. 1 : 181, Pl. 2, Fig. 1. 1933.

Our specimens are proportionately very long and frequently somewhat sigmoid. Length 200–272 μ, width 23.4 μ. Pl. I, Fig. 1. Moose Lake.

Netrium digitus var. lamellosum (De Bréb.) Grönblad; Krieger, *Die Desmidiaceen*, Teil 1, Lief. 1 : 219, Pl. 7, Fig. 6. 1933.

Length 155–191.5 μ, width at constriction 40 μ, maximum width 42.5 μ, width at poles 15.6 μ. Pl. II, Fig. 15. Moose Lake.

Netrium digitus var. Naegelii (De Bréb.) Krieger, *Die Desmidiaceen*, Teil 1, Lief. 1 : 218, Pl. 8, Figs. 4–5. 1933.

Length 156 μ, width 39.5 μ. Pl. II, Fig. 16. Moose Lake.

Penium phymatosporum Nordstedt; West and West, *British Desmidiaceae*, I : 91, Pl. 6, Figs. 9–11. 1904.

Length 35 μ, width 17 μ. Moose Lake, Hidden Lake.

Closterium angustatum Kuetz.; Krieger, *Die Desmidiaceen*, Teil 1, Lief. 2 : 363, Pl. 35, Figs. 2–4. 1935.

Wall yellowish, with four to six coarse striations. Length 400 μ, maximum width 19.5 μ, width at poles 11.7 μ. Pl. I, Figs. 13–15. Moose Lake, Hidden Lake.

Closterium Archerianum Cleve; Krieger, *Die Desmidiaceen*, Teil 1, Lief. 2 : 368, Pl. 36, Figs. 7–8. 1935.

Wall yellowish brown, particularly in older half of cell, with about fifteen striations visible. Length 148 μ, maximum width 20.5 μ, width at poles, 3.7 μ. Pl. I, Fig. 2. Passage Island.

Closterium Baillyanum De Bréb.; Krieger, *Die Desmidiaceen*, Teil 1, Lief. 2 : 327, Pl. 26, Figs. 7–8. 1935.

Wall colorless but becoming slightly tinged with yellow in age. Length 429 μ, maximum width 39 μ, width at poles 19.5 μ. Pl. I, Figs. 3–5. Wallace Lake. New record for Michigan.

Closterium Dianae Ehr.; Krieger, *Die Desmidiaceen*, Teil 1, Lief. 2 : 294, Pl. 19, Figs. 9–11; Pl. 20, Fig. 1. 1935.

Wall colorless, smooth. Length (distance between apices) 187 μ, width 18.5 μ. Pl. I, Fig. 9. Moose Lake.

Closterium intermedium var. hibernicum W. & G. S. West; West and West, *British Desmidiaceae*, I : 126, Pl. 14, Fig. 6. 1904.

Wall yellow to golden brown, with about eight striations visible. Length 312 μ, width 15.6 μ, width at poles 7.8 μ. Pl. I, Fig. 20. Moose Lake.

Closterium Leibleinii Kuetz.; Krieger, *Die Desmidiaceen*, Teil 1, Lief. 2 : 283, Pl. 17, Figs. 5–7. 1935.

Wall smooth, colorless. Length (distance between apices) 195 μ, width 39 μ. Pl. I, Fig. 21. Siskiwit Lake.

Closterium Lunula var. intermedium Gutw.; Krieger, *Die Desmidiaceen*, Teil 1, Lief. 2 : 303, Pl. 21, Fig. 3. 1935.

Wall smooth, colorless, suddenly tapering to broadly truncate poles. Length 522 μ, width 78–82 μ. Pl. I, Fig. 19. Locality of collection not given.

Closterium Navicula (De Bréb.) Lütkem.; Krieger, *Die Desmidiaceen*, Teil 1, Lief. 2 : 257, Pl. 12, Figs. 8–10. 1935.

Length 50 μ, width 15 μ. Moose Lake.

Closterium parvulum Naeg.; Krieger, *Die Desmidiaceen*, Teil 1, Lief. 2 : 275, Pl. 16, Figs. 14–17. 1935.

Wall smooth, colorless. Chloroplasts with one, rarely two, pyrenoids. Length (distance between apices) 85.8 μ, width 8 μ. Pl. I, Fig. 22. Moose Lake.

Closterium parvulum var. majus West; Krieger, *Die Desmidiaceen*, Teil 1, Lief. 2 : 277, Pl. 16, Fig. 18. 1935.

Wall smooth, colorless, cells somewhat stouter and larger throughout than in typical plant. Length (distance between apices) 124.8 μ, width 19.5 μ, width at poles 3 μ. Hidden Lake.

Closterium Pseudodianae Roy; West and West, *British Desmidiaceae*, I : 132, Pl. 15, Figs. 7–8. 1904.

Wall smooth, colorless. Length 185–196 μ, width 11–13 μ. Wallace Lake.

Closterium Ralfsii var. hybridum Rab.; West and West, *British Desmidiaceae*, I : 183, Pl. 24, Figs. 8–13. 1904.

Wall light tawny yellow, with twenty-five to thirty fine striae visible. Length 400 μ, width 31.2 μ. Pl. I, Figs. 6–8. Moose Lake.

Closterium strigosum var. elegans (G. S. West) Krieger, *Die Desmidiaceen*, Teil 1, Lief. 2 : 300, Pl. 20, Fig. 12. 1935.

Wall smooth, colorless. Length 429 μ, width 31.2 μ. Pl. I, Figs. 11–12. Moose Lake.

Closterium striolatum Ehr.; Krieger, *Die Desmidiaceen*, Teil 1, Lief. 2 : 337, Pl. 28, Figs. 8–9; Pl. 29, Fig. 9. 1935.

Wall yellow-brown, with thirty to forty striae visible. Length 333 μ, width 37 μ, width at poles 10 μ. Pl. I, Figs. 16–18. Moose Lake.

Closterium Venus Kuetz.; Krieger, *Die Desmidiaceen*, Teil 1, Lief. 2 : 272, Pl. 16, Figs. 1–5. 1935.

Cells small, strongly curved, two pyrenoids in each chloroplast. Wall smooth, colorless. Length (distance between apices) 46.8 μ, width 7.8 μ. Pl. I, Fig. 10. Rock pool on Bat Island.

Pleurotaenium Ehrenbergii (De Bréb.) De Bary; West and West, *British Desmidiaceae*, I : 205, Pl. 29, Figs. 9–11; Pl. 30, Fig. 1. 1904.

Length 390–429 μ, width 25–27.5 μ. Hidden Lake, Siskiwit Lake.

Pleurotaenium truncatum var. Farquharsonii (Roy & Biss.) West and West, *British Desmidiaceae*, I : 205, Pl. 29, Figs. 5–6. 1904.

Length 429 μ, width 62.4 μ. Hidden Lake. New record for North America.

Tetmemorus granulatus (De Bréb.) Ralfs; West and West, *British Desmidiaceae*, I : 219, Pl. 32, Figs. 7–9. 1904.

Wall sparsely and regularly punctate. Length 140.4 μ, width 43.9 μ. Pl. II, Fig. 3. Moose Lake.

Tetmemorus laevis (Kuetz.) Ralfs; West and West, *British Des midiaceae*, I : 222, Pl. 32, Figs. 11–16. 1904.

Wall smooth. Length 78 μ, width 23.4 μ. Pl. II, Figs. 1–2 Moose Lake and many other habitats on the island.

Arthrodesmus triangularis var. inflatus W. & G. S. West West and West, *British Desmidiaceae*, IV : 99, Pl. 114, Figs. 14–15. 1912.

Length 23.4 μ, width 19.5 μ including spines, isthmus 6 μ. Pl. II, Fig. 13. Moose Lake.

Desmidium Aptogonum De Bréb.; West and West, and Carter, *British Desmidiaceae*, V : 242, Pl. 164, Figs. 1–3. 1923.

Cells triangular in end view, showing prominent apical extensions, by which the cells are adjoined, in front view. Length 19.5 μ, width 31.2 μ. Pl. II, Fig. 10. Moose Lake.

Desmidium asymmetricum Grönblad, *Acta Soc. pro Fauna et Flora Fenn.*, 47 (4) : 85, Pl. 1, Figs. 5–7. 1920.

Cells triangular in vertical view; in front view cells within filament turned at various angles so that lobes of semicells lie in different planes. Length 15.6–23.4 μ, width 27.3–28 μ. Pl. II, Fig. 11. Moose Lake.

Desmidium Baileyi var. minor Allorge and Allorge, *Rev. Algol.*, 5 : 369, Pl. 15, Fig. 1. 1930.

Length 19.5 μ, width 19.5 μ. Pl. II, Fig. 12. Wallace Lake. New record for North America.

Desmidium Grevillei (Kuetz.) De Bary; Smith, *Phytoplankton Inland Lakes Wis.*, Part II : 145, Pl. 88, Fig. 8. 1924.

In vertical view elliptic and with prominent nodules at the poles. Length 27–35 μ, width 45–47 μ. Pl. II, Fig. 9. Moose Lake.

Desmidium Swartzii C. A. Agardh; West and West, and Carter, *British Desmidiaceae*, V : 246, Pl. 163, Figs. 5–8. 1923.

Cells triangular in end view; apices of cells adjoined by very short, inconspicuous extensions. Length 15–17.5 μ, width 32–35 μ. Pl. II, Fig. 8. Hidden Lake.

Hyalotheca dissiliens (Sm.) De Bréb.; West and West, and

Carter, *British Desmidiaceae*, V: 229, Pl. 161, Figs. 16–27. 1923.

Length 19.5 μ, width 31.2 μ. Pl. II, Figs. 5–7. Small pool near trail from Monument Rock to Tobin Harbor, widely distributed over the island.

Hyalotheca mucosa (Mert.) Ehr.; West and West, and Carter, *British Desmidiaceae*, V: 235, Pl. 162, Figs. 1–4. 1923.

Length 17 μ, width 15.6 μ. Pl. II, Fig. 4. Moose Lake.

Albion College
Albion, Michigan

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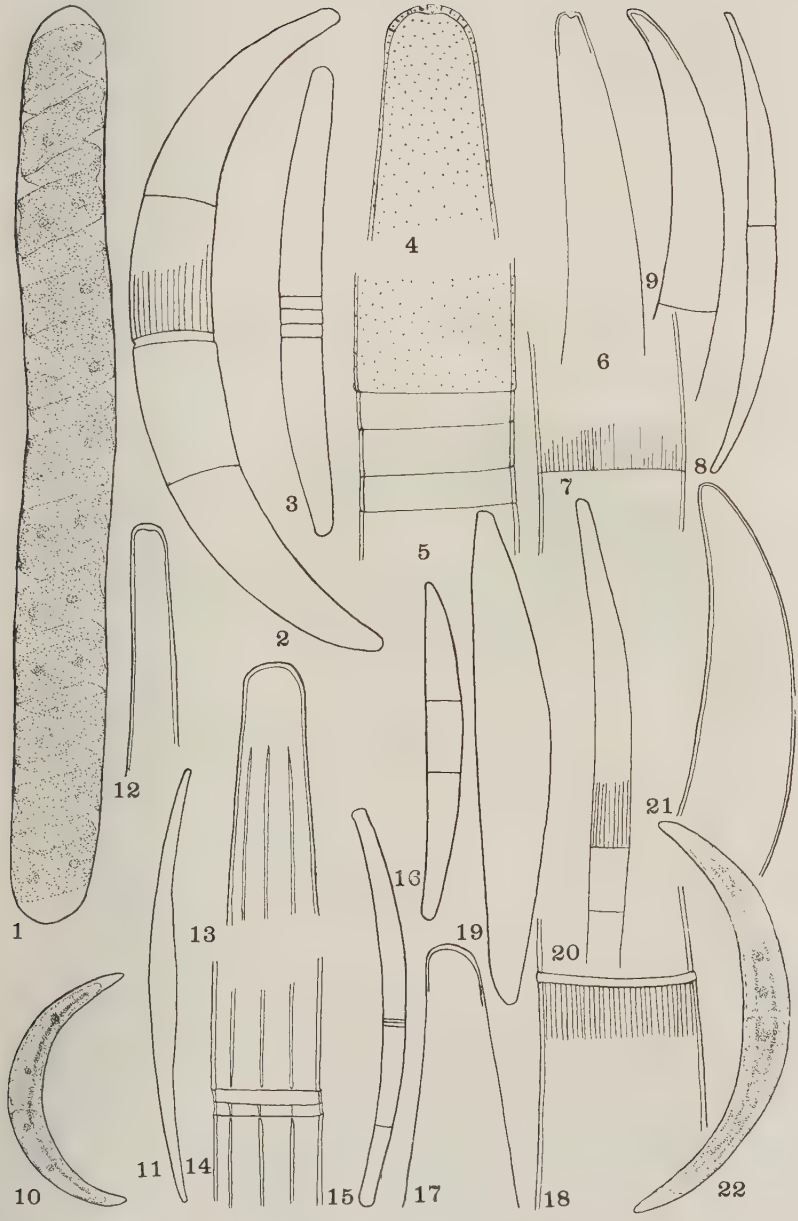
EXPLANATION OF PLATE I

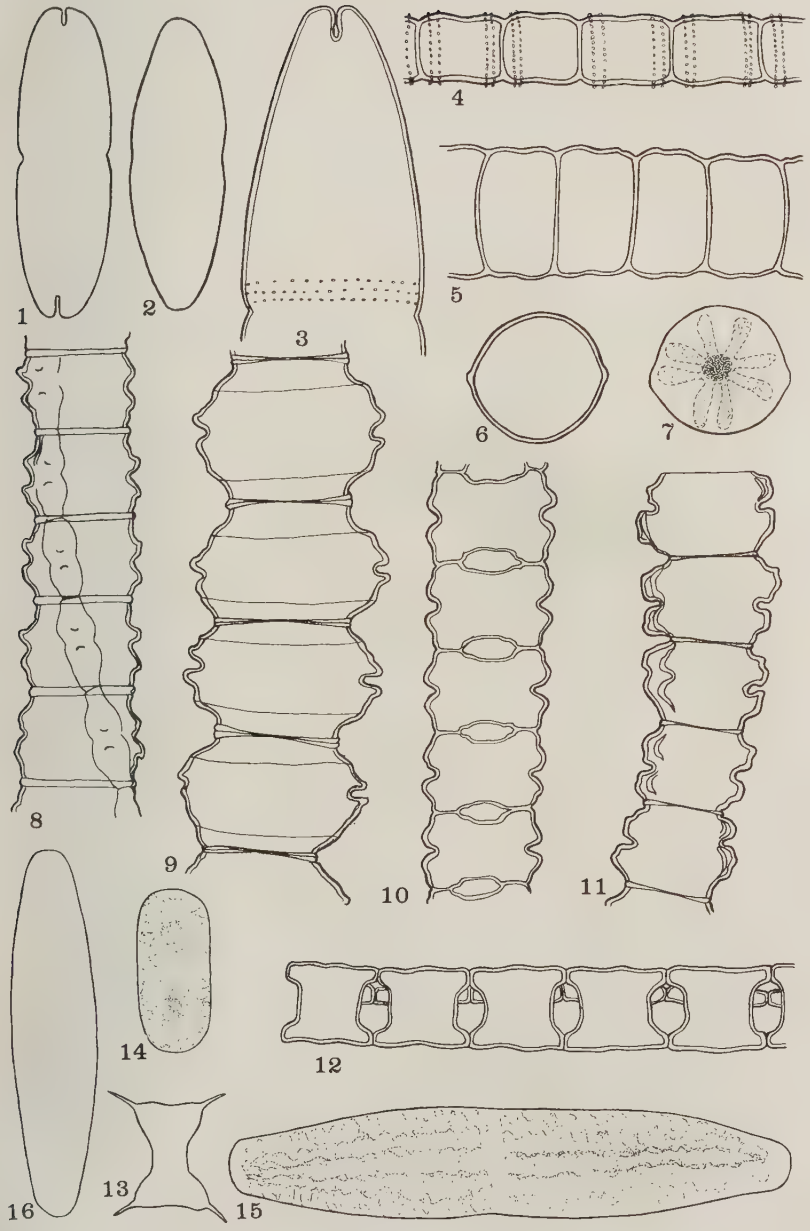
1. Spirotaenia condensata De Bréb. × 440
2. Closterium Archerianum Cleve. × 440
3–5. C. Baillyanum De Bréb. × 100
6–8. C. Ralfsii var. hybridum Rab. × 440
9. C. Dianae Ehr. × 440
10. C. Venus Kuetz. × 440
11–12. C. strigosum var. elegans (G. S. West) Krieger. Fig. 11, × 50; Fig. 12, × 440
13–15. C. angustatum Kuetz. Figs. 13–14, × 440; Fig. 15, × 100
16–18. C. striolatum Ehr. Fig. 16, × 220; Figs. 17–18, × 440
19. C. Lunula var. intermedium Gutw. × 100
20. C. intermedium var. hibernicum W. & G. S. West. × 50
21. C. Leibleinii Kuetz. × 440
22. C. parvulum Naeg. × 440



Desmids from Isle Royale

EXPLANATION OF PLATE II

1–2. Tetmemorus laevis (Kuetz.) Ralfs. × 440
3. T. granulatus (De Bréb.) Ralfs. × 330
4. Hyalotheca mucosa (Mert.) Ehr. × 440
5–7. H. dissiliens (Sm.) De Bréb. × 440
8. Desmidium Swartzii C. A. Agardh. × 440
9. D. Grevillei (Kuetz.) De Bary. × 440
10. D. Aptogonum De Bréb. × 100
11. D. asymmetricum Grönblad. × 440
12. D. Baileyi var. minor Allorge and Allorge. × 400
13. Arthrodesmus triangularis var. inflatus W. & G. S. West. × 440
14. Cylindrocystis Brebissonii Menegh. × 440
15. Netrium digitus var. lamellosum (De Bréb.) Grönblad. × 330
16. N. digitus var. Naegelii (De Bréb.) Krieger. × 220



Desmids from Isle Royale

DISTRIBUTION OF THE RANUNCULACEAE IN MICHIGAN *

BETTY M. ROBERTSON

BEAL'S *Michigan Flora*,[1] published in 1904, is the most recent systematic and distributional account of Michigan vascular plants as a whole available for reference. It was compiled at a time when the data pertinent to such an annotated list were very meager compared to the information now at one's disposal but still unassembled. Consequently, the student of the local flora has been seriously handicapped by the lack of a definitive, authoritative handbook. Until this difficulty has been solved by the publication of a comprehensive and detailed modern Flora of Michigan, it may be remedied in part by the presentation of careful studies of special groups, such as have already appeared in the *Reports* and *Papers* of the Michigan Academy of Science, Arts, and Letters for the Orchidaceae,[2] Violaceae,[3] Umbellales,[4] Ericales,[5] Cruciferae,[6] and Potamogeton.[7] It is with this end in view that a study of the Ranunculaceae is offered as a contribution to our knowledge of the state flora. In it are included all recently described species and varieties which have been found in Michigan. The nomenclature has been brought up to date throughout the family.

* Papers from the Department of Botany of the University of Michigan, No. 719.

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[5] *Idem*, "Distribution of the Ericales in Michigan," *ibid.*, 3 (1923) : 166–191. 1924.

[6] Walpole, Branson A., "Distribution of the Cruciferae in Michigan," *Pap. Mich. Acad. Sci., Arts, and Letters*, 6 (1926) : 307–349. 1927.

[7] Costing, Henry J., "Distribution of the Genus Potamogeton in Michigan," *Pap. Mich. Acad. Sci., Arts, and Letters*, 15 (1931) : 141–171. 1932.

This paper is based primarily upon material in the herbaria of the University of Michigan and of Michigan State College. Only those introduced species have been admitted as established members of the state flora which have persisted without cultivation over a period of several years and whose occurrence in Michigan is confirmed by a record specimen. Species reported to have been found in the state but for which no corroborating specimen could be located are listed at the end. Because of limitation of space only a single citation for each county is ordinarily given, generally not of the first collection, but of the specimen with the most explicit data.

The majority of the Ranunculaceae which are represented in Michigan are distributed throughout the greater part of the state, only four being restricted, so far as is known, to the Upper Peninsula, and seven to the Lower Peninsula. From fifteen of the counties no specimens could be found of any of the forty species — a significant indication of how much botanical exploration remains to be done in Michigan.

I wish to thank Dr. F. J. Hermann for suggesting this study of the Ranunculaceae and for his kind assistance.

KEY TO THE GENERA OF RANUNCULACEAE IN MICHIGAN

a. Fruit an achene; carpels 1-ovuled
  b. Sepals imbricated in bud; lower leaves alternate or radical; plants not climbing
    c. Petals evident, yellow or rarely white ..... 1. Ranunculus
    c. Petals none; sepals often large and petal-like
      d. Flowers small, numerous, panicled, not subtended by an involucre ..... 2. Thalictrum
      d. Flowers few, large, showy, subtended by an involucre
        e. Involucre remote from flower, leaflike
          f. Plants glabrous, from a cluster of thick tuberous roots; achenes ribbed ..... 3. Anemonella
          f. Plants hairy or pubescent; roots not tuberous; achenes not ribbed ..... 4. Anemone
        e. Involucre close under flower, calyx-like ..... 5. Hepatica
  b. Sepals valvate in bud; leaves opposite; plants climbing ... 6. Clematis
a. Fruit a follicle or a berry; carpels several-ovuled
  b. Fruit a follicle
    c. Flowers regular
      d. Petals none; sepals large, petal-like
        e. Sepals white; leaves compound ..... 7. Isopyrum
        e. Sepals yellow; leaves simple, kidney-shaped ..... 8. Caltha
      d. Petals present
        e. Petals large, spur-shaped ..... 9. Aquilegia
        e. Petals smaller, equal to or shorter than sepals, not spur-shaped

f. Pods sessile; leaves 5–7-parted. (See excluded species, p. 59.) ..... Trollius
f. Pods long-stalked; leaves trifoliolate, evergreen .. 10. Coptis
c. Flowers irregular; upper sepal long-spurred ..... 11. Delphinium
b. Fruit a berry
c. Flowers racemose; berries on conspicuous pedicels ..... 12. Actaea
c. Flowers solitary; berries sessile, aggregated into a head 13. Hydrastis

1. RANUNCULUS [Tourn.] L.

a. Aquatic or semiaquatic plants
b. Leaves all submerged, repeatedly dissected
c. Leaves sessile, from mostly broad stipular sheaths, not often collapsing when withdrawn from water
d. Achenes 8–30, averaging 16; beak of achene about 1 mm. long 1. *R. longirostris*
d. Achenes very many, 30–60, averaging usually 40; beak of achene 0.2–0.5 mm. long ..... 2. *R. subrigidus*
c. Leaves petioled, collapsing when withdrawn from water; stipular sheaths narrow except on immature leaves
d. Receptacle hairy; achenes 1.25–1.5 mm. long, frequently hairy at maturity ..... 3. *R. trichophyllus*
d. Receptacle nearly naked; achenes 1.5–1.75 mm. long, glabrous at maturity ..... 3a. *R. trichophyllus* var. *calvescens*
b. Leaves not all submerged, dissected, lobed, entire or denticulate
c. Leaves filiformly dissected
d. Not rooting out of water ..... 4. *R. flabellaris*
d. Rooting out of water..... 4a. *R. flabellaris* f. *riparius*
c. Leaves not filiformly dissected
d. Leaves palmately divided
e. Plant floating or creeping; branches prostrate or only slightly ascending; 1–4-flowered; bracteal leaves absent, or few and very small ..... 5. *R. Gmelini* var. *Purshii*
e. Plant upright; branches strongly ascending, 7–50-flowered; bracteal leaves numerous, the lower 1–4 cm. long 5a. *R. Gmelini* var. *prolificus*
d. Leaves simple, lanceolate or linear
e. Leaves 4–10 cm. long; achenes strongly beaked .. 6. *R. ambigens*
e. Leaves 0.5–5 cm. long; achenes mucronate with a short abrupt point
f. Leaves linear, filiform ..... 7. *R. reptans*
f. Leaves spatulate or oblong ..... 7a. *R. reptans* var. *ovalis*
a. Terrestrial plants but often in wet places
b. Achenes marginless; basal leaves entire or 3-lobed, all crenate
c. Petals large ..... 8. *R. rhomboideus*
c. Petals small
d. Head of fruit cylindric or oblong; achenes very numerous; basal leaves all lobed or parted ..... 9. *R. sceleratus*
d. Head of fruit subglobose; achenes few; basal leaves mostly not lobed
e. Basal cordate leaves with an open sinus

f. Peduncles, upper internodes, and leaf surfaces glabrous or essentially so ..... 10. *R. abortivus*
f. Young peduncles (at least toward base), upper internodes, and often surfaces of youngest cauline leaves minutely pilose ..... 10a. *R. abortivus* var. *acrolasius*
e. Basal leaves with a narrow or nearly closed sinus 10b. *R. abortivus* var. *eucyclus*
b. Achenes compressed, with an evident firm margin; leaves variously cleft or divided
c. Beak of achene long and strongly recurved; petals shorter than reflexed calyx ..... 11. *R. recurvatus*
c. Beak of achene not both long and recurved; petals usually longer than calyx
d. Beak of achene long, more than half length of achene
e. Roots thickened; stems 1–4 dm. high; achenes 2–2.6 mm. wide
f. Leaf segments narrow, leaf appearing pinnate 12. *R. fascicularis*
f. Leaf segments broad, oblong or obovate; leaves palmately 3-cleft or divided
g. Pubescence spreading ..... 13. *R. hispidus*
g. Pubescence appressed ..... 13a. *R. hispidus* var. *falsus*
e. Roots slender; stems 3–8 dm. high; achenes 3–3.4 mm. wide 14. *R. septentrionalis*
d. Beak of achene short, not more than half length of achene
e. Plants usually creeping or ascending; sepals not reflexed
f. Flowers 2–2.6 cm. in diameter
g. Pubescence appressed ..... 15. *R. repens*
g. Pubescence spreading
h. Plants creeping ..... 15a. *R. repens* var. *villosus*
h. Plants erect ..... 15b. *R. repens* var. *erectus*
f. Flowers not over 1.5 cm. in diameter. (See excluded species, p. 58.) ..... *R. Macounii*
e. Plants erect; sepals reflexed
f. Leaflets stalked; head of fruit oblong or cylindric 16. *R. pennsylvanicus*
f. Leaflets sessile; head of fruit globose ..... 17. *R. acris*

1. *Ranunculus longirostris* Godr. (*Rhodora*, 38 : 18. 1936)

R. circinatus of American authors, not Sibth.
Batrachium divaricatum (Schrank) Wimm.
B. circinatum (Sibth.) Reichenb.

Ponds and slow streams.

Specimens examined. — Van Buren Co., H. S. Pepoon, June, 1906. Calhoun Co., Rice Creek, C. M. Tarzwell 258. Jackson Co., Portage Lake, E. B. Mains, June, 1913. Washtenaw Co., near Ann Arbor, E. W. Erlanson 116. Barry Co., Lake Independence, D. E. Miller 39. Ingham Co., Lake Lansing, C. F. Wheeler, June, 1900. Oakland Co., C. Billington, June, 1922. Macomb Co.,

Washington, D. Cooley, June, 1840. Kent Co., Grand Rapids, H. M. Bailey, June, 1892. Genesee Co., Flint, D. Clark 4016. Lapeer Co., C. K. Dodge, June, 1893. St. Clair Co., near Algonac, C. K. Dodge, Aug., 1903. Muskegon Co., Black Lake, C. D. McLouth, July, 1894. Gratiot Co., Alma, C. A. Davis, June, 1889. Osceola Co., Muskegon River, H. T. Darlington, Aug., 1916. Roscommon Co., near Houghton Lake, Darlington and Bessey, July, 1916. Antrim Co., C. Leavitt, in 1890. Emmet Co., Crooked River at Alanson, J. H. Ehlers 5346. Cheboygan Co., Carp Creek, C. O. Erlanson 259. Luce and Mackinac Co., Manistique Lake, D. E. Miller 154. Alger Co., Chatham, C. F. Wheeler, Sept., 1900. Gogebic Co., near Watersmeet, H. T. Darlington, Aug., 1919.

Reported from Ionia Co., shallow streams, Hubbardston (W. B. Drew, *Rhodora*, 38 : 43. 1936).

2. *Ranunculus subrigidus* W. B. Drew, *Rhodora*, 38 : 39. 1936

"Persistent style-base forming a short beak (0.2–0.5 mm.) at maturity; achenes very many (30–80) but usually about 40, averaging 1.25 mm. in length: stipular sheaths pubescent or not, usually $\frac{3}{4}$ to completely adnate to the petioles . . . . Closely resembles *R. longirostris* in habit; but normally each species has distinctive fruit characters. *R. longirostris* bears from 8 to 30 (average 16) carpels" (W. B. Drew, *Rhodora*, 38 : 12, 41–42).

Specimen examined. — Iron Co., Liver-light Lakes, F. P. Metcalf 2223 (U. S. National Herbarium).

3. *Ranunculus trichophyllus* Chaix. (*Rhodora*, 38 : 18. 1936)

R. aquatilis L. var. *capillaceus* DC.
Batrachium trichophyllum (Chaix) Bosch in Beal, *Michigan Flora.*

Slow-flowing waters and ponds.

Specimens examined. — Washtenaw Co., C. A. Davis, June, 1890. Barry Co., Hastings Fish Hatchery, C. M. Tarzwell 282. Oakland Co., Pontiac, June, 1838. St. Clair Co., Algonac, H. H. Rush, Aug., 1884. Gratiot Co., Alma, C. A. Davis, May, 1896. Cheboygan Co., Maple River, J. H. Ehlers 1141. Chippewa Co., Prentis Bay Creek, J. H. Ehlers 1356. Alger Co., K. K. Mackenzie, Aug., 1916. Marquette Co., C. A. Davis, July, 1906. Gogebic Co., near Watersmeet, Bessey and Darlington,

Aug., 1919. Ontonagon Co., Porcupine Mts., H. T. Darlington, Aug., 1919. Keweenaw Co., O. A. Farwell, Aug., 1888; Isle Royale, A. E. Foote, in 1868.

Reported from: Allegan Co., Salem Township, F. A. Loew, in 1913. Manistee Co., Manistee, F. P. Daniels, in 1903. Cheboygan Co., Black Lake, Beal and Wheeler, in 1892.

3a. *Ranunculus trichophyllus* Chaix var. *calvescens* W. B. Drew, *Rhodora*, 38 : 32. 1936

No collections from Michigan referable to this variety could be found in the state herbaria.

Reported from Keweenaw Co., Farwell 134 (*Rhodora*, 38 : 32. 1936).

4. *Ranunculus flabellaris* Raf.

R. delphinifolius Torr.

Quiet waters; apparently absent from the Upper Peninsula.

Specimens examined. — Washtenaw Co., Steinbach Woods, E. W. Erlanson 931. Ingham Co., near Lansing, C. F. Wheeler, June, 1895. Livingston Co., Marion Township, F. C. Blanchard, May, 1933. Oakland Co., Royal Oak, C. Billington, May, 1921. Macomb Co., Washington, D. Cooley, June, 1850. St. Clair Co., near Port Huron, C. K. Dodge, May, 1900. Gratiot Co., Alma, C. A. Davis, May, 1890. Emmet Co., Carp River, C. O. Erlanson 335.

Reported from: Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Kent Co., Grand Rapids Township, Sister M. Marcelline Horton, in 1939.

4a. *Ranunculus flabellaris* Raf. f. *riparius* Fern., *Rhodora*, 38 : 171. 1936

R. delphinifolius Torr. var. *terrestris* of *Gray's New Manual*, Seventh Edition.

Rooting out of water.

Specimens examined. — Monroe Co., near Milan, B. M. Robertson 117. Macomb Co., Washington, D. Cooley, June, 1853. Ionia Co., Hubbardston, C. F. Wheeler, in 1870.

5. *Ranunculus Gmelini* DC. var. *Purshii* (Richards) Hara, *Rhodora*, 41 : 386. 1939

R. Purshii Richards.

Shallow pools, ditches, and on shores.

Specimens examined. — Ingham Co., Stockbridge, June, 1898. Gratiot Co., Alma, C. A. Davis, May, 1890. Alpena Co., near Alpena, C. F. Wheeler, July, 1895. Cheboygan Co., near Topinabee, J. H. Ehlers 3243, 3523. Delta Co., Chandler's Falls, C. F. Wheeler, Aug., 1892. Chippewa Co., near Vermilion, K. K. Mackenzie, June, 1914.

Reported from: Kent Co., near Grand Rapids, N. Coleman, in 1873. Emmet Co., Gates and Ehlers, in 1927. Gogebic Co., Gogebic Lake, H. T. Darlington, in 1920. Menominee Co., C. A. Davis, in 1908.

5a. *Ranunculus Gmelini* DC. var. *prolificus* (Fern.) Hara, *Rhodora*, 19 : 135. 1917; and 41 : 386. 1939

R. multifidus var. *terrestris* Gray.
R. Purshii var. *prolificus* Fern.

On muddy banks.

M. L. Fernald (*Rhodora*, 38 : 173. 1936) writes: "The type of *R. multifidus*, var. *terrestris* Gray belongs very definitely with *R. Purshii*, not with *R. flabellaris* and it is the upright paniculate-branched *R. Purshii*, var. *prolificus*."

The type of *R. multifidus* var. *terrestris* was collected at Ann Arbor by Miss Clark (Gray Herbarium).

Specimens examined. — Ingham Co., East Lansing, C. F. Wheeler, Sept., 1894. Alpena Co., Alpena, C. F. Wheeler, Aug., 1895.

Reported from Washtenaw Co., Ann Arbor, Miss Clark (*Gray's Manual*, Fifth Edition, p. 41. 1867).

6. *Ranunculus ambigens* S. Wats. (*Rhodora*, 38 : 173. 1936)

R. laxicaulis (T. & G.) Darby.
R. obtusiusculus Raf.

Southern Michigan; rare and local.

Specimens examined. — St. Clair Co., C. K. Dodge, Aug., 1904; Algonac, W. S. Cooper, Aug., 1903.

7. *Ranunculus reptans* L.

R. Flammula L. var. *reptans* (L.) Mey.

Sandy or gravelly shores; not seen from the center of the state.

Specimens examined. — Muskegon Co., near Twin Lake, C. D. McLouth, July, 1899. Cheboygan Co., C. O. Erlanson 598.

Alger Co., K. K. Mackenzie, Aug., 1916. Keweenaw Co., Isle Royale, C. A. Brown 3471, 3523.

Reported from: Wayne Co., Belle Isle, O. A. Farwell. St. Clair Co., Algonac, W. S. Cooper. Delta Co., Escanaba, E. J. Hill, in 1885. Chippewa Co., Homestead, F. J. Hermann 7149.

7a. *Ranunculus reptans* L. var. *ovalis* (Bigel.) T. & G. (*Rhodora*, 19 : 135. 1917)

Northern Michigan; in habitats similar to those of the species.

Specimens examined. — Cheboygan Co., Douglas Lake, J. H. Ehlers 8247. Ontonagon Co., Porcupine Mts., H. T. Darlington, Aug., 1923. Keweenaw Co., Bête Gris, F. J. Hermann 375.

8. *Ranunculus rhomboideus* Goldie. (*Rhodora*, 38 :175–177. 1936)

? *R. ovalis* Raf.

Southern Michigan; prairies and dry hills; rare.

Specimens examined. — St. Clair Co., near Port Huron, C. K. Dodge, April, 1894. Kent Co., Grand Rapids, E. J. Cole, May, 1901.

Reported from: Washtenaw Co., Pittsfield Township, B. A. Walpole, in 1924. Ionia Co., Muir and Palo. "Prairies, Michigan," in *Gray's New Manual*, Seventh Edition.

9. *Ranunculus sceleratus* L.

Wet ditches and swamps; frequent.

Specimens examined. — Monroe Co., near Milan, B. M. Robertson 241. Washtenaw Co., Nichols Arboretum, F. J. Hermann 1134. Wayne Co., Detroit Zoo, J. M. Sutton 396. Ingham Co., Lansing. Oakland Co., Independence Township, B. F. Chandler, May, 1913. Ottawa Co., Holland, C. H. Kauffman, Aug., 1910. St. Clair Co., near Port Huron, C. K. Dodge, June, 1892. Muskegon Co., Muskegon, W. J. Beal, June, 1898. Gratiot Co., Alma, C. A. Davis, May, 1892. Saginaw Co., Laport Road, R. R. Dreisbach 4814. Grand Traverse Co., Williamsburg, J. H. Ehlers 3442. Emmet Co., Big Stone Bay, C. O. Erlanson 554. Cheboygan Co., J. H. Ehlers 3239, 3357, 5584. Houghton Co., Laurium, F. J. Hermann 275. Keweenaw Co., Isle Royale, J. B. McFarlin 2322.

Reported from: Kalamazoo Co., C. R. and F. N. Hanes, in

1936. Manistee Co., Manistee, F. P. Daniels, in 1903. Mackinac Co., Mackinac Is., C. K. Dodge, in 1913. Gogebic Co., introduced at Ironwood, H. T. Darlington, in 1920.

10. *Ranunculus abortivus* L.

Many segregates from *R. abortivus* have been proposed as species, particularly by E. L. Greene, but in Michigan none of these appears to have characters of sufficient constancy to be of taxonomic significance.

Shady hillsides and along brooks; common.

Specimens examined. — Berrien Co., near Niles, B. M. Robertson 93. Monroe Co., near Milan, B. M. Robertson 67. Kalamazoo Co., Kalamazoo, R. M. Gibbs, May, 1877. Washtenaw Co., Speechley's Woods, E. W. Erlanson 951. Allegan Co., Swan Creek Experiment Station, F. W. Stuewer 170. Ingham Co., East Lansing, L. J. Cole, May, 1895. Livingston Co., Patterson Lake, C. O. Erlanson 58. Macomb Co., Washington, D. Cooley, May, 1849. Kent Co., H. M. Bailey, May, 1891. St. Clair Co., near Port Huron, C. K. Dodge, May, 1892. Gratiot Co., near Alma, C. A. Davis, May, 1888. Cheboygan Co., near Mud Lake, J. H. Ehlers 3366. Marquette Co., B. Barlow, May, 1901.

Reported from: St. Joseph Co., near Sturgis, F. P. Daniels, in 1903. Oakland Co., Parkedale Farm, O. A. Farwell, in 1913. Saginaw Co., Maple Grove Township, Sister M. Marcelline Horton, in 1925. Isabella Co., Mt. Pleasant, C. A. Davis, in 1888. Huron Co., Charity Is., C. K. Dodge, in 1911. Manistee Co., Manistee, F. P. Daniels, in 1903. Mackinac Co., Mackinac Is., C. K. Dodge, in 1913. Gogebic Co., H. T. Darlington, in 1920. Ontonagon Co., Porcupine Mts., H. T. Darlington.

10a. *Ranunculus abortivus* L. var. *acrolasius* Fern., *Rhodora*, 40 : 417. 1938

Swamps and bogs.

Specimens examined. — Wayne Co., Detroit Zoo, J. M. Sutton 396. Wexford Co., Harrietta, H. C. Skeels, May, 1895. Cheboygan Co., Douglas Lake, C. O. Erlanson 280. Houghton Co., Laurium, F. J. Hermann 245. Keweenaw Co., Copper Harbor, F. J. Hermann 7688.

10b. *Ranunculus abortivus* L. var. *eucyclus* Fern.

R. michiganensis Farwell.

Specimens examined. Berrien Co., C. Billington, May, 1921. Washtenaw Co., near Ann Arbor, C. O. Erlanson 17. Oakland Co., Independence Township, B. F. Chandler, May, 1913.

11. *Ranunculus recurvatus* Poir.

Woods and swamps; common.

Specimens examined. — Berrien Co., near Niles, B. M. Robertson 95. Cass Co., Cassopolis, C. F. Wheeler, June, 1890. Van Buren Co., Keeler, H. S. Pepoon, May, 1906. Calhoun Co., B. M. Robertson 182. Washtenaw Co., Steinbach Woods, E. W. Erlanson 920. Wayne Co., Linden Park, G. Suttie, June, 1893. Ingham Co., East Lansing, H. C. Skeels, May, 1894. Macomb Co., Washington, D. Cooley, May, 1829. Kent Co., near Grand Rapids, H. M. Bailey, in 1891. Shiawassee Co., Owosso, G. H. Hicks, May, 1889. St. Clair Co., C. K. Dodge, June, 1913. Gratiot Co., Alma, C. A. Davis, May, 1888. Saginaw Co., R. R. Dreisbach, June, 1931. Benzie Co., Inland, June, 1888. Antrim Co., C. Leavitt, May, 1891. Emmet Co., J. H. Ehlers 1200. Cheboygan Co., Douglas Lake, J. H. Ehlers 3359. Marquette Co., B. Barlow, June, 1901. Gogebic Co., Slate River, H. T. Darlington, Aug., 1919. Houghton Co., near Lake Linden, F. J. Hermann 457.

Reported from: Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Oakland Co., Parkedale Farm, O. A. Farwell, in 1913. Huron Co., Charity Is., C. K. Dodge, in 1911. Newaygo Co., north of Bridgeton, F. J. Hermann 8611. Mackinac Co., Mackinac Is., C. K. Dodge, in 1913. Manistee Co., Manistee, F. P. Daniels, in 1903. Ontonagon Co., Porcupine Mts., H. T. Darlington. Keweenaw Co., south of Cliff, F. J. Hermann 7649.

12. *Ranunculus fascicularis* Muhl.

Dry or moist hills; frequent in the southern counties, rare in the Upper Peninsula.

Specimens examined. — Hillsdale Co., near Moscow, B. M. Robertson 85. Washtenaw Co., Lima Township, J. H. Ehlers 1874. Allegan Co., Swan Creek Experiment Station, A. O. Haugen 62. Oakland Co., Bloomfield Township, B. F. Chandler, June, 1913.

Kent Co., Grand Rapids, D. S. Bailey, May, 1892. St. Clair Co., near Roberts Landing, C. K. Dodge, May, 1910. Marquette Co., Huron Mt., C. K. Dodge, June, 1917.

Reported from: Berrien Co., H. S. Pepoon. Cass Co., Sister M. Marcelline Horton, in 1916. St. Joseph Co., Sturgis, F. P. Daniels, in 1903. Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Saginaw Co., Maple Grove Township, Sister M. Marcelline Horton, in 1939.

13. *Ranunculus hispidus* Michx.

Southern Michigan; moist places, chiefly woods.

Specimen examined. — Wayne Co., Eight-Mile Road, J. M. Sutton, May, 1913.

Reported from: Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Kent Co., Walker Township, Sister M. Marcelline Horton, in 1939. Washtenaw Co., Ypsilanti Township, B. A. Walpole, in 1924. Iosco Co., Sister M. Marcelline Horton, in 1930. Cheboygan Co., Gates and Ehlers, in 1924.

13a. *Ranunculus hispidus* Michx. var. *falsus* Fern., *Rhodora*, 22 : 30. 1920

Range and habitat apparently those of the species.

Specimens examined. — Allegan Co., Swan Creek Experiment Station, A. O. Haugen 142. Ingham Co., East Lansing, L. J. Cole, May, 1895. Kalamazoo Co., Climax Township, C. R. Hanes, in 1939. Kent Co., Grand Rapids, H. C. Skeels, May, 1895.

14. *Ranunculus septentrionalis* Poir.

R. caricetorum Greene.

Moist or shady places.

Specimens examined. — Berrien Co., Warren Woods, C. Billington, May, 1920. Hillsdale Co., Hillsdale, D. A. Pelton, May, 1885. Van Buren Co., Keeler, H. S. Pepoon, May, 1906. Jackson Co., S. H. and D. R. Camp, May, 1893. Washtenaw Co., Cedar Bend, J. H. Ehlers 670. Wayne Co., B. F. Chandler, May, 1913. Macomb Co., Washington, D. Cooley, May, 1843. Ionia Co., Hubbardston, C. F. Wheeler, June, 1890. St. Clair Co., Port Huron, C. K. Dodge, May, 1892. Gratiot Co., Alma, C. A. Davis, May, 1891. Cheboygan Co., Burt Lake, J. H. Ehlers 43. Chippewa Co., C. K. Dodge, June, 1914. Keweenaw Co., Copper Harbor, F. J. Hermann 7788.

Reported from: St. Joseph Co., Sturgis, F. P. Daniels, in 1903. Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Kent Co., Plaster Creek, Sister M. Marcelline Horton. Saginaw Co., Maple Grove Township, Sister M. Marcelline Horton, in 1939. Manistee Co., Manistee, F. P. Daniels, in 1903. Gogebic Co., H. T. Darlington, in 1920.

15. *Ranunculus repens* L.

Waste places; local.

Specimens examined. — St. Clair Co., Port Huron, C. K. Dodge, Sept., 1896. Cheboygan Co., J. H. Ehlers 4640 (small specimen with pubescence appressed; flowers 1.5 cm. wide).

Reported from: Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Washtenaw Co., Ypsilanti, B. A. Walpole, in 1924. Oakland Co., Rochester, W. A. Brotherton and O. A. Farwell. Manistee Co., Manistee, F. P. Daniels, in 1903. Keweenaw Co., Montreal River, O. A. Farwell.

15a. *Ranunculus repens* L. var. *villosus* Lamotte. (*Conn. Geol. and Nat. Hist. Surv.*, Bull. No. 48 : 47. 1930)

Specimens examined. — St. Clair Co., Port Huron, C. K. Dodge, June, 1897. Cheboygan Co., J. H. Ehlers 3531, 3639. Gogebic Co., Slate River, H. T. Darlington, Aug., 1919. Ontonagon Co., Porcupine Mts., H. T. Darlington, Aug., 1923.

15b. *Ranunculus repens* L. var. *erectus* DC. (*Conn. Geol. and Nat. Hist. Surv.*, Bull. No. 48 : 47. 1930)

Specimens examined. — Washtenaw Co., Lewis Foote, May, 1863. Shiawassee Co., Owosso, G. H. Hicks, April, 1889. St. Clair Co., Port Huron, C. K. Dodge, July, 1898. Gratiot Co., Alma, C. A. Davis, May, 1888. Oscoda Co., Comins, June, 1888.

16. *Ranunculus pennsylvanicus* L. f.

Wet places; frequent.

Specimens examined. — Cass Co., Silver Creek, H. S. Pepoon, Aug., 1905. Van Buren Co., Aug., 1838. Washtenaw Co., Forestry Farm, E. W. Erlanson 5371. Wayne Co., Belle Isle, H. H. Rush, Aug., 1884. Eaton Co., near Grand Ledge, B. M. Robertson 341. Ingham Co., East Lansing, L. J. Cole, Aug., 1895. Livingston Co.,

Whitmore Lake, J. Dawson. Oakland Co., Royal Oak Township, B. F. Chandler, July, 1916. Macomb Co., Washington, D. Cooley, Aug., 1840. Ottawa Co., Holland, L. H. Pennington, Aug., 1910. Kent Co., Grand Rapids, H. M. Bailey, July, 1891. Shiawassee Co., Owosso, G. H. Hicks, July, 1889. Genesee Co., Flint, D. Clark 951. Gratiot Co., Alma, C. A. Davis, July, 1889. Clare Co., Farwell, H. T. Darlington, Aug., 1916. Roscommon Co., Bessey and Darlington, July, 1916. Grand Traverse Co., Green Lake Township, June, 1888. Emmet Co., Pellston, J. H. Ehlers 1024. Cheboygan Co., Douglas Lake, C. O. Erlanson 546. Chippewa Co., Prentis Bay, J. H. Ehlers 1359. Marquette Co., near Big Bay, K. K. Mackenzie, July, 1916. Ontonagon Co., Porcupine Mts., H. T. Darlington, Aug., 1923. Houghton Co., Bear Lake, F. J. Hermann 665. Keweenaw Co., Clifton, O. A. Farwell, Aug., 1888.

Reported from: Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Saginaw Co., Sister M. Marcelline Horton, in 1924. Huron Co., Charity Is., C. K. Dodge, in 1911. Luce Co., shore of Lake Manistique, F. J. Hermann 8307. Gogebic Co., Cisco Lake, H. T. Darlington, in 1920.

17. *Ranunculus acris* L.

Moist meadows; generally local and infrequent in the south, abundant in the Upper Peninsula.

Specimens examined. — Washtenaw Co., E. W. Erlanson 137. Wayne Co., Lewis Foote, June, 1870. Allegan Co., Swan Creek Experiment Station, F. W. Stuewer 135. Ingham Co., East Lansing, H. C. Skeels, June, 1894. Ottawa Co., Holland, C. H. Kauffman, Aug., 1910. Kent Co., W. E. Mulliken, Aug., 1897. St. Clair Co., Grant Township, C. K. Dodge, May, 1911. Cheboygan Co., J. H. Ehlers 357, 6047. Mackinac Co., Prentis Bay, J. H. Ehlers 1449. Chippewa Co., Whitefish Point, C. Billington, Aug., 1923. Marquette Co., A. Dachnowski and C. A. Davis, July, 1906. Gogebic Co., H. T. Darlington, June, 1920. Houghton Co., Laurium, F. J. Hermann 236, 597.

Reported from: Van Buren Co., South Haven, W. J. Beal, in 1904. Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Eaton Co., near Bellevue, I. H. Hall, in 1870. Macomb Co., W. J. Beal, in 1904. Genesee Co., Flint, W. J. Beal, in 1904. Saginaw Co., Chesaning Township, Sister M. Marcelline Horton, in 1925. Charle-

voix Co., Sister M. Marcelline Horton, in 1933. Keweenaw Co., Isle Royale, McCargoe Cove, A. H. W. Povah, in 1934.

2. THALICTRUM [Tourn.] L.

a. Leaflets suborbicular
  b. Achenes thick-walled; leaflets glandular-pruinose, glaucous beneath, coarsely toothed; estival ..... 1. *T. confine*
  b. Achenes thin-walled; leaflets thin, light green, glabrous, usually 5–7-lobed; vernal ..... 2. *T. dioicum*
a. Leaflets oblong, more or less pubescent, usually 3-toothed; estival 3. *T. dasycarpum*

1. *Thalictrum confine* Fern.

Glades and openings in thicket bordering calcareous beach of Lake Michigan.

Specimen examined. — Schoolcraft Co., east of Manistique, M. L. Fernald and A. S. Pease 3306.

2. *Thalictrum dioicum* L.

Rich or rocky woods; common.

Specimens examined. — Berrien Co., Warren Woods, C. Billington, May, 1921. Cass Co., near Lime Lake, B. M. Robertson 206. Hillsdale Co., near Moscow, B. M. Robertson 86. Lenawee Co., near Clinton, B. M. Robertson 77. Monroe Co., near Milan, B. M. Robertson 73. Washtenaw Co., southwest of Platt, E. W. Erlanson and F. J. Hermann 5009. Oakland Co., Addison Township, C. Billington, June, 1924. Kent Co., Grand Rapids, H. M. Bailey, May, 1892. St. Clair Co., Port Huron, C. K. Dodge, May, 1901. Gratiot Co., Alma, C. A. Davis, May, 1888. Cheboygan Co., Douglas Lake, J. H. Ehlers 1591, 1603. Ontonagon Co., Porcupine Mts., H. T. Darlington, Aug., 1923.

Reported from: St. Joseph Co., Sturgis, F. P. Daniels, in 1903. Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Ottawa Co., Tallmadge Township, C. W. Bazuin, in 1939. Saginaw Co., Maple Grove Township, Sister M. Marcelline Horton, in 1939. Isabella Co., Mt. Pleasant, C. A. Davis, in 1888. Huron Co., Charity Is., C. K. Dodge, in 1911. Manistee Co., Manistee, F. P. Daniels, in 1903. Gogebic Co., near Bass Lake, H. T. Darlington, in 1920. Lenawee Co., Adrian, F. L. Stearns, in 1905.

3. *Thalictrum dasycarpum* Fisch. & Lall.

T. purpurascens of American authors, not L.

Rich damp open ground, generally on banks of lakes and rivers or in swamps and bogs.

Specimens examined. — Monroe Co., near Milan, B. M. Robertson 136. Washtenaw Co., north bank Huron River, E. W. Erlanson 138, 5189. Wayne Co., Detroit Zoo, J. M. Sutton, July, 1916. Eaton Co., near Grand Ledge, B. M. Robertson 341. Oakland Co., C. Billington, July, 1916. St. Clair Co., near Port Huron, C. K. Dodge, July, 1914. Gratiot Co., Alma, C. A. Davis, June, 1891. Cheboygan Co., Maple River, J. H. Ehlers 536. Mackinac Co., banks of Brevort River, J. H. Ehlers 4556. Chippewa Co., Prentis Bay, C. O. Erlanson 740. Ontonagon Co., Porcupine Mts., H. T. Darlington, Aug., 1923.

Reported from: Kalamazoo Co., north of Vicksburg, F. J. Hermann 9012. Kent Co., Plainfield Township, C. W. Bazuin, in 1939. Isabella Co., Mt. Pleasant, C. A. Davis, in 1888. Huron Co., Charity Is., C. K. Dodge, in 1911. Mackinac Co., Mackinac Is., C. K. Dodge, in 1913. Gogebic Co., H. T. Darlington, in 1920. Houghton Co., near Lake Linden, F. J. Hermann 441. Keweenaw Co., marsh near Cliff, F. J. Hermann 8052.

3. ANEMONELLA Spach.

Anemonella thalictroides (L.) Spach.

Syndesmon thalictroides (L.) Hoffmg.

Woods; probably restricted, in Michigan, to the southern half of the Lower Peninsula.

Specimens examined. — Berrien Co., near Niles, B. M. Robertson 101. St. Joseph Co., near White Pigeon, B. M. Robertson 92. Lenawee Co., near Clinton, B. M. Robertson 75. Van Buren Co., Magician Lake, H. S. Pepoon, May, 1903. Washtenaw Co., White's Woods, F. J. Hermann 51. Ingham Co., East Lansing, H. C. Skeels, April, 1894. Livingston Co., E. S. George Reserve, J. H. Ehlers 5037. Oakland Co., Farmington Township, B. F. Chandler, May, 1916. Kent Co., Grand Rapids, H. M. Bailey, May, 1892.

Reported from Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Keweenaw Co., O. A. Farwell (Beal, *Michigan Flora*).

4. ANEMONE [Tourn.] L.

a. Achenes densely woolly
  b. Sepals red ..... 1. *A. multifida* var. *hudsoniana* f. *sanguinea*
  b. Sepals greenish white
    c. Head of fruit cylindrical; divisions of cauline leaves 3–5 cm. long, cleft into rather narrow segments; sepals rather obtuse 2. *A. cylindrica*
    c. Head of fruit ovoid; divisions of cauline leaves 6–10 cm. long, much less finely cleft; sepals acute ..... 3. *A. virginiana*
a. Achenes pubescent or naked
  b. Involucral leaves sessile; plant tall, over 20 cm. high; flowers several ..... 4. *A. canadensis*
  b. Involucral leaves long-petioled, trifoliolate; plant low, less than 20 cm. high; flowers solitary ..... 5. *A. quinquefolia* var. *interior*

1. *Anemone multifida* Poir. var. *hudsoniana* DC. f. *sanguinea* (Pursh) Fern., *Rhodora*, 19 : 141. 1917

A. hudsoniana Richards.

Plentiful along sandy shores or dunes of the Great Lakes.

Specimens examined. — Benzie Co., near South Frankfort, W. A. Weir, June, 1893. Leelanau Co., Sleeping Bear Point, J. H. Ehlers 4024. Presque Isle Co., near Rogers City, C. K. Dodge, Sept., 1913. Emmet Co., Big Stone Bay, J. H. Ehlers 3399. Cheboygan Co., Bois Blanc Is., C. Billington, Aug., 1916. Alpena Co., near Alpena, C. K. Dodge, July, 1912. Mackinac Co., Prentis Bay, J. H. Ehlers 2977. Keweenaw Co., Isle Royale, A. E. Foote, in 1869.

Reported from: Tuscola Co., C. A. Davis, in 1904. Bay Co., C. A. Davis, in 1904. Iosco Co., Au Sable River, Sister M. Marcelline Horton, in 1939. Antrim Co., Torch Lake, E. J. Hill, in 1881. Charlevoix Co., Beaver Is., Sister M. Marcelline Horton, in 1939.

2. *Anemone cylindrica* Gray

Sandy soil and rocky woods.

Specimens examined. — Berrien Co., Niles, July, 1867. Monroe Co., Monroe. Van Buren Co., Keeler, H. S. Pepoon, Aug., 1905. Washtenaw Co., Ann Arbor, C. D. LaRue, July, 1915. Wayne Co., Detroit Zoo, J. M. Sutton 401. Ingham Co., Lake Lansing, July, 1888. Oakland Co., Avon Township, C. Billington, July, 1918. Kent Co., Grand Rapids, H. M. Bailey, July, 1893.

Ionia Co., Hubbardston, C. F. Wheeler. St. Clair Co., near Port Huron, July, 1906. Muskegon Co., W. J. Beal, June, 1898. Newaygo Co., Hess Lake, H. T. Darlington, Aug., 1916. Montcalm Co., Greenville, B. Barlow, Sept., 1900. Huron Co., Hume Township, C. A. Davis, June, 1896. Lake Co., Baldwin, July, 1888. Arenac Co., near Omer, C. F. Wheeler, Aug., 1900. Iosco Co., East Tawas, H. H. Bartlett, July, 1928. Alpena Co., Alpena, C. A. Davis, June, 1891. Cheboygan Co., Douglas Lake, J. H. Ehlers 941. Presque Isle Co., Rogers City, F. J. Hermann 1213. Delta Co., north of Garden, M. L. Fernald and A. S. Pease 3308. Mackinac Co., Scotty Bay, C. O. Erlanson 770.

Reported from: St. Joseph Co., Sturgis, F. P. Daniels, in 1902. Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Manistee Co., Manistee, F. P. Daniels, in 1903. Emmet Co., Gates and Ehlers, in 1924.

3. *Anemone virginiana* L.

Woods and meadows; frequent.

Specimens examined. — Berrien Co., near Birchwood Beach, C. K. Dodge, Aug., 1917. Monroe Co., Milan, B. M. Robertson 310. Van Buren Co., Keeler, H. S. Pepoon. Jackson Co., Francisco, C. H. Kauffman and B. B. Kanouse, Aug., 1923. Washtenaw Co., near Ann Arbor, F. J. Hermann 1235. Wayne Co., Dearborn Township, C. Billington, July, 1917. Allegan Co., Swan Creek Experiment Station, A. O. Haugen 196. Eaton Co., near Grand Ledge, B. M. Robertson 349. Ingham Co., E. Lansing, H. C. Skeels, July, 1894. Oakland Co., Rochester, O. A. Farwell 6960. Macomb Co., Washington, D. Cooley, July, 1847. Ottawa Co., Holland, C. H. Kauffman, Aug., 1910. Kent Co., Grand Rapids, H. M. Bailey, July, 1893. Ionia Co., Hubbardston, C. F. Wheeler, June, 1890. Shiawassee Co., Owosso, G. H. Hicks, July, 1889. St. Clair Co., Port Huron, C. K. Dodge, July, 1895. Montcalm Co., Crystal Lake, C. F. Wheeler, July, 1900. Gratiot Co., Alma, C. A. Davis, June, 1890. Oscoda Co., W. J. Beal and C. F. Wheeler, July, 1888. Alpena Co., Thunder Bay, J. H. Ehlers 3168. Emmet Co., Cecil Bay, J. H. Ehlers 2176. Cheboygan Co., Burt Lake, J. H. Ehlers 2057. Gogebic Co., near Watersmeet, H. T. Darlington, Aug., 1919.

Reported from: St. Joseph Co., Sturgis, F. P. Daniels, in 1903.

Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Huron Co., Charity Is., C. K. Dodge, in 1911. Manistee Co., Manistee, C. K. Dodge, in 1913.

4. *Anemone canadensis* L.

Along stream banks; common.

Specimens examined. — Monroe Co., near Monroe, B. M. Robertson 137. Van Buren Co., South Haven, L. H. Pennington, July, 1910. Washtenaw Co., Huron River at Ypsilanti, B. A. Walpole, May, 1918. Allegan Co., Swan Creek Experiment Station, F. W. Stuewer 215. Eaton Co., near Grand Ledge, B. M. Robertson 350. Ingham Co., East Lansing, H. T. Darlington, June, 1916. Kent Co., Grand Rapids, H. M. Bailey, June, 1891. St. Clair Co., Port Huron, C. K. Dodge, June, 1892. Muskegon Co., W. J. Beal, June, 1898. Gratiot Co., Alma, C. A. Davis, June, 1889. Midland Co., near Midland, R. R. Dreisbach, July, 1927. Chippewa Co., Prentis Bay, C. O. Erlanson 738. Cheboygan Co., Burt Lake, C. O. Erlanson 202. Marquette Co., B. Barlow, July, 1901. Gogebic Co., Watersmeet, H. T. Darlington, Aug., 1919. Houghton Co., Bear Lake, F. J. Hermann 666. Keweenaw Co., Copper Harbor, F. J. Hermann 505.

Reported from: St. Joseph Co., Sturgis, F. P. Daniels, in 1903. Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Oakland Co., Parkedale Farm, O. A. Farwell, in 1913. Ottawa Co., Grand Haven Township, Sister M. Marcelline Horton, in 1939. Saginaw Co., Maple Grove Township, Sister M. Marcelline Horton, in 1934. Arenac Co., Rifle River, Sister M. Marcelline Horton, in 1926. Manistee Co., Manistee, F. P. Daniels, in 1904. Emmet Co., Gates and Ehlers, in 1924. Mackinac Co., Mackinac Is., C. K. Dodge, in 1913. Ontonagon Co., Porcupine Mts., H. T. Darlington.

5. *Anemone quinquefolia* L. var. *interior* Fern., *Rhodora*, 37 : 260. 1935

"Nearly all material of *A. quinquefolia* from the Great Lakes region north to James Bay has the stem of the flowering plants spreading-villous as are the petioles of the leaves of the 1-leaved young plants and often the petioles of the involucral leaves and

the peduncles of the flowers. Var. *interior* is, then, a well-defined inland variety . . . " (M. L. Fernald, *loc. cit.*).

In the study of herbarium material for this paper no Michigan collections of the glabrous typical *A. quinquefolia* were found.

Margins of woods; common.

Specimens examined. — Berrien Co., Paris, H. M. Bailey, May, 1891. Cass Co., H. S. Pepoon, May, 1905. Hillsdale Co., near Moscow, B. M. Robertson 87. Monroe Co., near Milan, B. M. Robertson 61. Kalamazoo Co., Kalamazoo, R. M. Gibbs, May, 1877. Washtenaw Co., south of Ann Arbor, C. O. Erlanson 25. Wayne Co., Detroit Zoo, J. M. Sutton 402. Allegan Co., Swan Creek Experiment Station, F. W. Stuewer 185. Ingham Co., East Lansing, L. J. Cole, May, 1895. Oakland Co., Rochester, O. A. Farwell 7711. Kent Co., Grand Rapids, H. C. Skeels, May, 1895. Ionia Co., Hubbardston, C. F. Wheeler, June, 1890. St. Clair Co., near Port Huron, C. K. Dodge, May, 1892. Gratiot Co., Alma, C. A. Davis, May, 1892. Iosco Co., Au Sable River, J. H. Ehlers 4767. Crawford Co., near Grayling, June, 1888. Marquette Co., near Humboldt, M. L. Fernald and A. S. Pease 3310. Houghton Co., Laurium, F. J. Hermann 272. Keweenaw Co., O. A. Farwell, June, 1888; Isle Royale, A. E. Foote, in 1868.

Reported from: St. Joseph Co., Sturgis, F. P. Daniels, in 1903. Saginaw Co., Sister M. Marcelline Horton, in 1925. Bay Co., G. M. Bradford. Emmet Co., near Pellston, A. Sharp. Manistee Co., Manistee, F. P. Daniels, in 1903. Mackinac Co., Mackinac Is., C. K. Dodge, in 1913. Gogebic Co., Bessemer-Ironwood region, H. T. Darlington, in 1920. Ontonagon Co., Porcupine Mts., H. T. Darlington.

5. HEPATICA [Rupp.] Hill

a. Involucral bracts and lobes of leaves obtuse ..... 1. *H. americana*
a. Involucral bracts and lobes of leaves acute ..... 2. *H. acutiloba*

1. *Hepatica americana* (DC.) Ker. (*Rhodora*, 19 : 14. 1917)

H. triloba of American authors, not Chaix.
H. Hepatica of American authors, not Karst.

Common in woods and on wooded dunes.

Flowers normally blue. The white-flowered form is f. *candida* Fern.; the pink-flowered, f. *rhodantha* Fern. (*Rhodora*, 19 : 45. 1917).

Specimens examined. — Berrien Co., J. Colvin 1060. Hillsdale Co., Hillsdale, D. A. Pelton, May, 1885. Cass Co., near Jones, B. M. Robertson 210. Washtenaw Co., Ann Arbor, G. W. Allyn, May, 1873. Wayne Co., Dearborn, B. F. Chandler, Oct., 1916. Allegan Co., Swan Creek Experiment Station, A. O. Haugen 61. Macomb Co., Washington, D. Cooley, Aug., 1900. Kent Co., Grand Rapids, H. M. Bailey, May, 1891. St. Clair Co., near Port Huron, C. K. Dodge, May, 1892. Muskegon Co., Lake Michigan, E. A. Bessey, Aug., 1916. Gratiot Co., near Alma, C. A. Davis, April, 1892. Midland Co., one mile west of Averill, R. R. Dreisbach 4702. Calhoun Co., Marshall, W. J. Beal, Aug., 1898. Oscoda Co., W. J. Beal and C. J. Wheeler, July, 1888. Cheboygan Co., Douglas Lake, J. H. Ehlers 2335. Alger Co., Chatham, C. F. Wheeler, Aug., 1900. Gogebic Co., Gogebic Lake, H. T. Darlington, Aug., 1919. Keweenaw Co., Copper Harbor, F. J. Hermann 220.

Reported from: St. Joseph Co., Sturgis, F. P. Daniels, in 1903. Lenawee Co., Adrian, F. L. Stearns, in 1905. Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Jackson Co., G. H. Hicks, in 1893. Ottawa Co., Tallmadge Township, C. W. Bazuin, in 1939. Huron Co., Charity Is., C. K. Dodge, in 1911. Manistee Co., Manistee, F. P. Daniels, in 1903. Emmet Co., Gates and Ehlers, in 1924. Ontonagon Co., Porcupine Mts., H. T. Darlington. Mackinac Co., Mackinac Is., C. K. Dodge, in 1913.

2. *Hepatica acutiloba* DC.

H. acuta (Pursh) Britton.

Common in beech and maple woods.

Specimens examined. — Berrien Co., Warren Woods, C. Billington, July, 1919. Cass Co., Magician Lake, H. S. Pepoon 663. Hillsdale Co., Hillsdale, D. A. Pelton, May, 1885. Washtenaw Co., five miles south of Ann Arbor, C. O. Erlanson 960. Wayne Co., Greenfield Township, B. F. Chandler, April, 1916. Ingham Co., East Lansing, H. C. Skeels, April, 1894. Kent Co., Grand Rapids, H. M. Bailey, May, 1892. Shiawassee Co., Owosso, G. H. Hicks, April, 1889. St. Clair Co., near Port Huron, C. K. Dodge, April, 1896. Gratiot Co., Alma, C. A. Davis, April, 1888. Wexford Co., Harrietta, H. C. Skeels, May, 1895. Otsego Co., near Vanderbilt, E. A. Bessey, July, 1912. Ontonagon Co., Porcupine Mts., H. T. Darlington, Aug., 1923.

Reported from: Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Oceana Co., Weare Township, Sister M. Marcelline Horton, in 1917. Huron Co., Charity Is., C. K. Dodge, in 1911. Newaygo Co., Fremont Lake, F. J. Hermann 8685. Manistee Co., Manistee, F. P. Daniels, in 1903. Cheboygan Co., near Mackinac City, O. A. Farwell, in 1896. Mackinac Co., Mackinac Is., C. K. Dodge, in 1913.

6. CLEMATIS L.

a. Flowers white, 2 cm. in diameter, in leafy panicles ..... 1. *C. virginiana*
a. Flowers purplish, 5–7.5 cm. in diameter, solitary in the axils or at the ends of the branches ..... 2. *C. verticillaris*

1. *Clematis virginiana* L.

Low woods; frequent.

Specimens examined. — Berrien Co., Warren Woods, C. Billington, July, 1919. Cass Co., Dowagiac Swamp, F. C. Gates, Aug., 1906. St. Joseph Co., White Pigeon, Aug. Branch Co., July 27 (1838?). Washtenaw Co., Ann Arbor along Huron River, E. C. Almendinger, Aug., 1861. Ingham Co., East Lansing, H. C. Skeels, Oct., 1894. Macomb Co., Washington, D. Cooley, May, 1843. Ottawa Co., Holland, L. H. Pennington, Aug., 1910. Kent Co., Grand Rapids, H. M. Bailey, July, 1891. St. Clair Co., near Port Huron, C. K. Dodge, Aug., 1896. Gratiot Co., Alma, C. A. Davis, Aug., 1889. Missaukee Co., Bessey and Darlington, Aug., 1916. Roscommon Co., Higgins Lake, H. T. Darlington, July, 1916. Emmet Co., Maple River, J. H. Ehlers 609. Cheboygan Co., Lancaster Lake, J. H. Ehlers 1685. Mackinac Co., Bois Blanc Is., J. H. Ehlers 5135. Marquette Co., B. Barlow, July, 1901. Gogebic Co., State Line to Watersmeet, H. T. Darlington, Aug., 1919. Ontonagon Co., Porcupine Mts., H. T. Darlington, July, 1922. Keweenaw Co., near Silver Isle, F. J. Hermann 718.

Reported from: Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Oakland Co., Parkedale Farm, O. A. Farwell, in 1913. Manistee Co., Manistee, F. P. Daniels, in 1903.

2. *Clematis verticillaris* DC.

Atragene americana Sims.

In Michigan apparently restricted to the Upper Peninsula; rocky hills; rare.

Specimens examined. — Iron Co., near Crystal Falls, C. A. Davis, Aug., 1905. Keweenaw Co., Isle Royale, C. A. Brown 3223, 3298, 3313.

Reported from Dickinson Co., Norway, S. M. Tobey.

7. ISOPYRUM L.

Isopyrum biternatum (Raf.) T. & G.

Locally common in beech and maple woods in the southern half of the Lower Peninsula.

Specimens examined. — Berrien Co., C. Billington, May, 1921. Van Buren Co., H. S. Pepoon, June, 1906. Kalamazoo Co., Kalamazoo, G. B. Sudworth, April, 1877. Washtenaw Co., Lodi, V. M. Spalding, May, 1892. Wayne Co., Plymouth, E. H. Ryder, May, 1898. Eaton Co., Bellevue, E. C. Almendinger. Ingham Co., East Lansing, H. C. Skeels, May, 1894. Kent Co., Grand Rapids, H. M. Bailey, May, 1891. Ionia Co., Hubbardston, C. F. Wheeler, May, 1876. Shiawassee Co., Owosso, G. H. Hicks, April, 1889. Gratiot Co., Alma, C. A. Davis, May, 1888.

Reported from: Ottawa Co., Tallmadge Township, Sister M. Marcelline Horton, in 1919. Saginaw Co., Maple Grove Township, Sister M. Marcelline Horton, in 1939.

8. CALTHA [Rupp.] L.

Caltha palustris L.

In swamps; very common.

Specimens examined. — Berrien Co., near Niles, B. M. Robertson 100. Cass Co., near Lime Lake, B. M. Robertson 197. Washtenaw Co., near Ypsilanti, B. A. Walpole, March, 1918. Wayne Co., Detroit, J. M. Sutton, May, 1916. Allegan Co., Swan Creek Experiment Station, A. O. Haugen 73. Kent Co., Grand Rapids, H. M. Bailey, April, 1892. Ionia Co., Hubbardston, C. F. Wheeler. St. Clair Co., near Port Huron, C. K. Dodge, May, 1895. Gratiot Co., Alma, C. A. Davis, May, 1891. Bay Co., Kowkaulin, R. R. Dreisbach 4686. Clare Co., near Dodge, R. R. Dreisbach 4677. Cheboygan Co., Carp Creek, J. H. Ehlers 885. Houghton Co., F. J. Hermann 189.

Reported from: St. Joseph Co., Sturgis, F. P. Daniels, in 1903. Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Oakland Co., Parkedale Farm, O. A. Farwell, in 1913. Manistee Co., Manistee, F. P. Daniels, in 1903. Wexford Co., Harrietta, H. C. Skeels, in 1896. Emmet Co., Gates and Ehlers, in 1924. Mackinac Co., Mackinac Is., C. K. Dodge, in 1913. Gogebic Co., H. T. Darlington, in 1920. Ontonagon Co., Porcupine Mts., H. T. Darlington.

9. AQUILEGIA [Tourn.] L.

Aquilegia canadensis L.

Open or rocky woods; frequent.

Specimens examined. — Berrien Co., C. Billington, May, 1921. Cass Co., Cassopolis, C. F. Wheeler, in 1890. Washtenaw Co., Ann Arbor, A. J. Pieters, June, 1893. Wayne Co., Detroit Zoo, J. M. Sutton, May, 1916. Allegan Co., Swan Creek Experiment Station, A. O. Haugen 130. Ingham Co., Lansing, F. L. Sleeper, June, 1866. Livingston Co., Strawberry Lake, J. H. Ehlers 1893. Oakland Co., Birmingham, J. M. Sutton, May, 1913. Kent Co., South Grand Rapids, G. Fyfe and J. Shaddick, May, 1895. Ionia Co., Hubbardston, C. F. Wheeler. Lapeer Co., south of Lapeer, C. K. Dodge, May, 1912. St. Clair Co., near Port Huron, C. K. Dodge, June, 1892. Gratiot Co., Alma, C. A. Davis, May, 1891. Midland Co., five miles north of Sanford, R. R. Dreisbach 4746. Antrim Co., Spencer Creek, C. Leavitt, June, 1891. Charlevoix Co., E. A. Bessey, Aug., 1912. Cheboygan Co., near Topinabee, J. H. Ehlers 6045. Delta Co., near Burnt Bluff, F. J. Hermann 6300. Mackinac Co., Goose Is., J. H. Ehlers 419.

Reported from: St. Joseph Co., Sturgis, F. P. Daniels, in 1903. Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Bay Co., Linwood Beach, in 1926. Huron Co., Charity Is., C. K. Dodge, in 1911. Manistee Co., Manistee, F. P. Daniels, in 1903. Leelanau Co., Sister M. Marcelline Horton, in 1928. Grand Traverse Co., Sister M. Marcelline Horton, in 1929. Emmet Co., Gates and Ehlers, in 1924. Mackinac Co., Mackinac Is., C. K. Dodge, in 1913. Ontonagon Co., Porcupine Mts., H. T. Darlington. Keweenaw Co., near Black Creek, F. J. Hermann 615.

10. COPTIS Salisb.

Coptis groenlandica (Oeder) Fern., *Rhodora*, 31 : 142. 1929

C. trifolia of American authors, not Salisb.

Mossy woods, bogs and swamps; commoner northward.

Specimens examined. — Berrien Co., Paris, H. M. Bailey, May, 1892. Cass Co., Dowagiac, L. M. Umbach, Aug., 1904. Hillsdale Co., Hillsdale, D. A. Pelton, May, 1885. Washtenaw Co., Ann Arbor, W. Lewis, May, 1892. Ingham Co., Lansing, C. A. Davis, June, 1892. Oakland Co., Bloomfield Hills, C. Billington, May, 1916. Ottawa Co., Holland, C. H. Kauffman, Aug., 1910. Genesee Co., Flint, D. Clark 954. St. Clair Co., near Port Huron, C. K. Dodge, May, 1892. Gratiot Co., Alma, C. A. Davis, May, 1888. Midland Co., near Midland, R. R. Dreisbach 4693. Wexford Co., Harrietta, H. C. Skeels, May, 1895. Antrim Co., Elk Rapids, A. B. Lyons, in 1867. Cheboygan Co., Burt Lake, C. O. Erlanson 212. Schoolcraft Co., near Gulliver Lake, J. H. Ehlers 4327. Mackinac Co., Prentis Bay, J. H. Ehlers 1447. Chippewa Co., Sugar Is., F. J. Hermann 7039. Marquette Co., Marquette, A. Dachnowski, Aug., 1906. Gogebic Co. (?), Mamie Lake, H. T. Darlington, Aug., 1919. Houghton Co., near Laurium, F. J. Hermann 251. Keweenaw Co., Eagle Harbor, F. J. Hermann 7574.

Reported from: Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Jackson Co., G. H. Hicks, in 1893. Iosco Co., Au Sable River, Sister M. Marcelline Horton, in 1939. Emmet Co., Gates and Ehlers, in 1924. Ontonagon Co., Porcupine Mts., H. T. Darlington.

11. DELPHINIUM L.

Delphinium Ajacis L.

Roadside. An escape from cultivation which is reported to persist.

Specimen examined. — St. Clair Co., Port Huron, C. K. Dodge, Sept., 1892.

Reported from: Van Buren Co., Keeler, H. S. Pepoon, in 1908. Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Washtenaw Co., Ypsilanti, O. A. Farwell, in 1894.

12. ACTAEA L.

a. Pedicels slender, long, hollow; inflorescence an ovoid cluster; fruits with numerous seeds, 11–17
  b. Fruit red ..... 1. *A. rubra*
  b. Fruit white ..... 1a. *A. rubra* f. *neglecta*
a. Pedicels stout, solid; inflorescence elongate-oblong; fruits with not very numerous seeds, 9–14; fruit white ..... 2. *A. pachypoda*

1. *Actaea rubra* (Ait.) Willd.

Swamps and rich woods; increasingly common northward.

Specimens examined. — Allegan Co., Swan Creek Experiment Station, F. W. Stuewer 224. Washtenaw Co., Lefurge Woods, B. A. Walpole, May, 1918. Wayne Co., Birmingham, J. M. Sutton 408. Ingham Co., East Lansing, H. C. Skeels, May, 1894. Oakland Co., Goodison, O. A. Farwell 7784. St. Clair Co., near Port Huron, C. K. Dodge, Aug., 1896. Gratiot Co., Alma, C. A. Davis, June, 1891. Roscommon Co., Higgins Lake, H. T. Darlington, July, 1916. Kent Co., Grand Rapids, S. R. Bailey, Aug., 1893. Iosco Co., along Cooke Dam Pond, J. H. Ehlers 4775. Emmet Co., Arnott Lake, C. O. Erlanson 413. Cheboygan Co., Burt Lake, C. O. Erlanson 246. Mackinac Co., Prentis Bay, C. O. Erlanson 667. Marquette Co., B. Barlow, May, 1901. Gogebic Co., near Watersmeet, H. T. Darlington, Aug., 1919. Ontonagon Co., Porcupine Mts., H. T. Darlington, Aug., 1923. Houghton Co., near Bear Lake, F. J. Hermann 432, 675. Keweenaw Co., Bête Gris, F. J. Hermann 335; Isle Royale, A. E. Foote, in 1868.

Reported from: Berrien Co., Warren Woods, C. Billington, in 1925. Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Saginaw Co., Sister M. Marcelline Horton, in 1925. Grand Traverse Co., Sister M. Marcelline Horton, in 1928.

1a. *Actaea rubra* (Ait.) Willd. f. *neglecta* (Gillman) Robinson

A. eburnea Rydb.
A. alba (L.) Mill. according to Marie-Victorin in *Flore Laurentienne* (p. 232).

Specimens examined. — Kent Co., Grand Rapids, S. R. Bailey, Aug., 1893. Roscommon Co., island in Higgins Lake, C. Billington, Aug., 1919. Emmet Co., Cecil Bay, J. H. Ehlers 1659, 2167. Cheboygan Co., Douglas Lake, F. C. Gates, July, 1911. Mackinac Co., Bois Blanc Is., J. H. Ehlers 5148. Houghton Co., F. J. Hermann 779. Keweenaw Co., near Ojibway, F. J. Hermann 2181.

2. *Actaea pachypoda* Ell. (Marie-Victorin, *Flore Laurentienne*, p. 232. 1935)

A. alba of recent American authors; doubtfully *A. spicata* var. *alba* of L.

Rich woods.

Specimens examined. — Berrien Co., Warren Woods, C. Billington, July, 1919. Cass Co., Magician Lake, L. M. Umbach 961. Van Buren Co., South Haven, L. H. Pennington, June, 1910. Washtenaw Co., Cascade Glen, Ann Arbor, F. J. Hermann 6883. Wayne Co., Detroit, O. A. Farwell 7809. Ingham Co., Lansing, in 1864. Oakland Co., Walled Lake, O. A. Farwell 4491. Ottawa Co., Grand Haven, Lewis Foote, Aug., 1870. Kent Co., Grand Rapids, H. M. Bailey, Aug., 1891. Ionia Co., Hubbardston, C. F. Wheeler. St. Clair Co., near Port Huron, C. K. Dodge, June, 1892. Muskegon Co., Slocum, C. D. McLouth, Aug., 1899. Newaygo Co., Hess Lake, H. T. Darlington, Aug., 1916. Bay Co., Bay City, I. Tillapaugh 189. Arenac Co., Big Charity Is., C. K. Dodge, Sept., 1910. Charlevoix Co., E. A. Bessey, Aug., 1912. Cheboygan Co., Burt Lake, J. H. Ehlers 3341. Schoolcraft Co., dune region of Gulliver Lake, J. H. Ehlers 4169. Mackinac Co., dune region of Brevort Lake, J. H. Ehlers 4490. Marquette Co., B. Barlow, Aug., 1901. Ontonagon Co., Porcupine Mts., H.T. Darlington, Aug., 1923. Houghton Co., west of Calumet, F. J. Hermann 433. Keweenaw Co., O. A. Farwell, July, 1888.

Reported from: Kalamazoo Co., C. R. and F. N. Hanes, in 1936. Montcalm Co., Pierson Township, Sister M. Marcelline Horton. Saginaw Co., Sister M. Marcelline Horton, in 1923. Manistee Co., Manistee, F. P. Daniels, in 1903. Leelanau Co., Sister M. Marcelline Horton, in 1928. Emmet Co., Gates and Ehlers, in 1924. Gogebic Co., H. T. Darlington, in 1920.

13. HYDRASTIS Ellis

Hydrastis canadensis L.

Rich woods in the three southernmost tiers of counties; rare.

Specimens examined. — Hillsdale Co., near Hillsdale, D. A. Pelton, May, 1888. Washtenaw Co., Third Woods, Ann Arbor, F. J. Hermann 104. Ingham Co., Lansing, F. L. Sleeper, May, 1867. Oakland Co., Commerce, O. A. Farwell 7386. St. Clair Co., near Port Huron, C. K. Dodge, June, 1899.

Reported from: St. Joseph Co., Sturgis, F. P. Daniels, in 1903. Kalamazoo Co., C. R. and F. N. Hanes, in 1936.

EXCLUDED SPECIES

Ranunculus Cymbalaria Pursh

Oxygraphis Cymbalaria (Pursh) Prantl.
Halerpestes Cymbalaria (Pursh) Greene.

Reported from South Haven by Beal in *Michigan Flora.* He ascribes the report to L. H. Bailey, but no specimen could be found to confirm the record.

Ranunculus bulbosus L.

Specimens of this introduced species from Washtenaw and Ingham counties have been seen. Beal reports it from Bay, Chippewa, and Keweenaw counties, with the statement "a bad weed in meadows." No recent specimens are known, however, the only two collections which could be found having been made in 1863 and 1894. The plant is evidently not becoming established in the state.

R. bulbosus resembles *R. acris* in habit but may be distinguished from that species by its stalked terminal leaflets, the swollen, corm-like base of its stem, and its reflexed sepals.

Ranunculus acris var. *flore pleno* Hort.

O. A. Farwell reported this horticultural form as an escape around Ypsilanti in 1894.

A double-flowered race of *R. acris* was reported from Cheboygan Co. by Gates and Ehlers in 1931. It is presumably an escape, but is spreading.

Ranunculus trifoliatus Muhl.

No specimens of this plant could be found, but O. A. Farwell reports it for Stony Creek and La Salle in Washtenaw and Monroe counties. *R. trifoliatus* resembles *R. septentrionalis* and may be an ecological form of it. *R. trifoliatus* is a plant of dry land, early becoming glabrous and rarely stoloniferous.

Ranunculus lucidus Poir.?

O. A. Farwell reported this species from Monroe Co. in 1921. Other reports or specimens were not found.

Ranunculus Macounii Britton

I am referring to this species a collection by H. S. Pepoon, from Van Buren County, June, 1906. Two others, Alger Co., Chatham, C. F. Wheeler, Aug., 1900, and Gogebic Co., Slate River, H. T. Darlington, Aug., 1919, appear to be nearest *R. Macounii*, and the localities are more compatible with its known range, but because these specimens are incomplete they cannot be placed with certainty.

Ranunculus lapponicus L.

Beal reports this species from "Thunder Bay, Lake Superior, Britton and Brown." This Thunder Bay is on the north shore of Lake Superior, in Ontario, and is not the Thunder Bay near Alpena, Michigan.

Thalictrum polygamum Muhl.

Reported from Gogebic Co. by Darlington and from Keweenaw Co. by Beal for Farwell, but no corroborating specimens could be located. The occurrence of the plant in Michigan is improbable since, as the species is now interpreted, its range does not extend west of the Alleghenies. Its nearest ally, *T. perelegans* Greene, occurs farther west and probably does extend north of Indiana.

T. polygamum may be distinguished from the common *T. dasycarpum* by its ovate, obtuse anthers, which are less than a millimeter in length. The anthers of *T. dasycarpum* are linear and mucronate.

Anemone riparia Fern.

No Michigan collections of this species were found. Beal ascribes reports for it from Wayne and Oakland counties to Farwell.

Anemone parviflora Michx.

In Beal's *Michigan Flora* reports for the state, without more definite locality, are credited to A. B. Lyons and Asa Gray. The report by Macoun from Pic River, Lake Superior, which is also cited by Beal, pertains to Ontario.

Anemone patens L. var. *Wolfgangiana* (Bess.) Koch.

No specimen could be located to substantiate Beal's report of this Anemone (as *Pulsatilla hirsutissima*) from Dickinson Co. The re-

port is ascribed to S. M. Tobey. Farwell reported it, as *Pulsatilla patens* var. *Wolfgangiana*, from Keweenaw Co.

Aquilegia vulgaris L.

The cultivated columbine occasionally escapes from gardens and has been reported from Keweenaw Co. by Farwell, from Washtenaw Co. by Walpole, and from Mackinac Is. by Dodge. There is no evidence to indicate that it has become established in Michigan.

Trollius laxus Salisb.

Beal credits a report of the globeflower from Genesee Co. to A. W. Chase, and the species is ascribed to Michigan in *Gray's New Manual*, Seventh Edition, and in Britton and Brown's *Illustrated Flora*, Second Edition, but no specimens from Michigan have been found.

Delphinium Consolida L.

A European species reported from Washtenaw Co. by Farwell in 1894, but no specimen could be found. Practically all American reports of this species prove to have been based upon specimens of *D. Ajacis*.

University of Michigan

NEW AND UNUSUAL AGARICS FROM MICHIGAN. II *

ALEXANDER H. SMITH

THE six species of agarics reported in this paper are distributed in Collybia, Lactarius, Lepiota, Pleurotus, Marasmius, and Psilocybe. Two of these have not previously been described, two are new to the Michigan flora, and two hitherto poorly known have been critically studied. The specimens have been deposited in the University of Michigan Herbarium. All color names within quotation marks are taken from R. Ridgway, *Color Standards and Color Nomenclature*, Washington, D.C., 1912. A solution of five parts chloral hydrate, two parts water, and an excess of iodine was used to determine the iodine reaction of the spores.

List of Species

Collybia hymenocephala, sp. nov. — Pileus 2–3 cm. latus, convexus, glaber, olivaceobrunneus, hygrophanus, demum pallidus, atomatus; lamellae denticulatae, latae, pallidae demum cinereae; stipes 4–5 cm. longus, 2–3 mm. crassus, aequalis, solidus, cartilagineus, striatus, pallide cinereus; sporae 6–7 × 5 5.5 μ, ellipsoideae. Specimen typicum legit A. H. Smith n. 11050, prope Dexter, Mich., Sept. 23, 1938; in Herb. Univ. Mich. conservatum.

Pileus 2–3 cm. broad, convex or obtuse when young, the margin at first incurved, broadly convex to plane in age, glabrous, "olive-brown" to "buffy brown" when fresh, hygrophanous, fading to "tilleul buff" (whitish), or more olivaceous gray, atomate and glistening when faded, not striate; flesh concolorous with the surface in moist or faded condition, thin, very soft and fragile, odor not distinctive, taste slightly farinaceous; lamellae depressed-adnate but toothed, subdistant (18–20 reach the stipe), 2–3 tiers of short individuals, moderately broad (2.5–3 mm.),

* Papers from the Herbarium of the University of Michigan.

"tilleul buff" or becoming darker and grayish in age, edges slightly uneven; stipe 4–5 cm. long, 2–3 mm. thick, equal, solid, cartilaginous, fragile, longitudinally appressed-fibrillose-striate (not with superficial fibrils and not pruinose near the apex), color pallid to ashy brown (almost concolorous with the faded pileus); spores 6–7 × 5–5.5 μ, broadly ellipsoid, white in mass, dark blue in iodine, smooth; basidia four-spored, 26–28 × 7–8 μ; pleurocystidia and cheilocystidia not differentiated; gill trama homogeneous, pale sordid yellowish brown in iodine; pileus trama corticated by a palisade of inflated, pedicellate cells 25–36 × 20–25 μ, the remainder homogeneous.

Scattered on wet ground near the edge of a swampy area, Dexter, September 23, 1938 (no. 11050).

I have found this species but once. Its characters are so distinctive, however, that I have no hesitation in describing it. The lax flesh, the pale sordid olive-brown color of the pileus when moist, the atomate glistening appearance of faded specimens, the palisade of inflated cells over the pileus, and the strong bluish reaction of the spores in iodine are all outstanding. In stature it resembles *Collybia ludoviciana* Murr., which, however, is much more cartilaginous (dried material of both compared), and its spores are yellowish in iodine. *C. fissilis* Maire is also readily distinguished by the iodine reaction of the spores.

Lactarius psammicola, sp. nov. (Pl. I). — Pileus 5–10 cm. latus, subinfundibuliformis, glutinosus, valde strigosus demum subglaber, zonatus, aurantiacus vel pallide aurantiacoluteus; lac album demum in speciminibus fractis pallide vinaceum, intense acre; lamellae confertae, angustae, decurrentes, pallidae demum subochraceae; stipes 1–3 cm. longus, 1.5–2 cm. crassus, scrobiculatus, farctus demum cavus, pallidus; sporae 7–8 × 5–6.5 μ. Specimen typicum legit A. H. Smith n. 1710, prope Dexter, Mich., Aug. 5, 1935; in Herb. Univ. Mich. conservatum.

Pileus 5–10 cm. broad, the center deeply depressed, the margin inrolled, expanding and broadly vase-shaped in age, glutinous and slimy when fresh, surface covered by masses of agglutinated fibrils, margin coarsely fibrillose or strigose at first, merely appressed-fibrillose in age, conspicuously zonate when young, obscurely so in age, colors "ochraceous buff" to "ochraceous orange" and zoned by "light buff" bands, finally becoming

sordid yellowish brown; flesh thick, tapered evenly to the margin, sordid buff, exuding a white latex when cut or bruised; latex copious, staining the lamellae "pale grayish vinaceous" (pinkish lilac) or changing very slowly to that color when in contact with the air, extremely acrid; lamellae close, narrow, decurrent, "light buff" to nearly white at first, becoming darker and sordid ochraceous in age; stipe 1–3 cm. long, 1.5–2 cm. thick, whitish, at times scrobiculate-spotted, tapering abruptly at the base, interior stuffed to hollow and whitish or sordid gray; spores 7–8 × 5–6.5 μ, ellipsoid, coarsely reticulated.

Gregarious on sandy soil under scrub oak and aspen near Dexter, August 5, 1935 (no. 1710, type). Additional collections were found near Pinckney and Ann Arbor during the same season.

This is a curious species because of its colors and very acrid taste, combined with the slowly changing milk and coarse fibrils, which at first cover the pileus. It is similar in many respects to *Lactarius torminosus* Fr., but differs decidedly in color. The colors are very similar to those of *L. insulsus* Fr., but usually a little paler (yellowish orange). Specimens were sent to Miss G. S. Burlingham, who reported that she knew of no described species with these characters. She commented on the similarity of the spores of *L. psammicola* to those of *L. torminosus*, and expressed the opinion that the former would have to be distinguished by the changing milk and the fibrillose surface of the entire pileus. I have collected *L. torminosus* in the same locality with *L. psammicola*, and have found the fibrillose surface covering to vary greatly in both species. In each it is sometimes very dense and persistent over the entire cap. The darker colors and the changing milk of the latter are sufficient to distinguish it.

Lepiota lenticularis (Lasch) Gillet (Pl. II). — Pileus 6–15 cm. broad, very obtuse when young, becoming broadly umbonate at maturity or the margin elevated slightly and the umbo disappearing, glabrous and viscid when young, in age the cuticle sometimes separating into fibrils and then appearing obscurely virgate, margin often splitting radially, cuticle sometimes subrimose, the exposed flesh appearing whitish, cuticle evenly "vinaceous buff" and remaining so throughout development, in

age the disc often marked with roundish more or less watery spots, margin incurved and cottony-fibrillose when young; flesh white, thick (7–8 mm. near the stipe), unchanging, odor subfarinaceous when cut, taste almost mild or slightly fungoid; lamellae approximate to the stipe but free, very close (120-130 almost reach the stipe), many short individuals present, broad (1 cm. ±), pure white until late maturity, then dull grayish to olivaceous gray, especially along the edges; stipe 10–15 cm. long, 1–2.5 cm. thick, solid, base somewhat enlarged into an oval bulb which is rounded below, conspicuously longitudinally appressed-fibrillose-striate above and below the superior membranous annulus, neither scaly nor sheathed, flesh nearly "tilleul buff" (pallid), surface somewhat darker; annulus membranous, thin, sometimes evanescent, fibrillose above and below, dull pale vinaceous gray, paler than the pileus; spores 4–5 × 3.5–4 μ, white in mass, ellipsoid to subglobose, not amyloid, smooth; cheilocystidia and pleurocystidia not differentiated; pileus trama homogeneous beneath a thin gelatinous pellicle, as in *Lepiota solidipes* Pk.; see Smith (7).

Gregarious under elm and ash in a dry swamp, South Lyons, October 5, 1938 (no. 11105).

My specimens were collected in very dry weather, and the only traces of olive color appeared near the edges of the gills in old pilei. In Europe the species is generally described as having exuded drops of liquid on various parts, and these are said to become sordid olivaceous as they dry. Considering the circumstances under which my specimens were collected, the absence of such drops and the stains which result from them is not taxonomically significant.

In the Michigan collection the stipe was solid and not scaly. Lange (5) illustrates the species as having a scaly stipe, but Fries (3) has not shown this character in his illustration, although he described it (2) as "plus minus *squamulosus*, interdum fere glaber . . . ." He also described it as "solidus, sed admodum spongioso-mollis (nec durus, rigidus uti prioris)." The fibrillose coating over the stipes of my specimens could very easily become torn into squamules. Had these specimens possessed truly glabrous stipes with a smooth polished cuticle, the difference would be more important.

Lepiota Fischeri Kauff. is very close to this species, as Kauffman pointed out. It has, however, smaller spores, a differently colored pileus, and a peculiar odor when drying.

Marasmius polyphyllus Pk. — Pileus 2–4 cm. broad, convex when young, soon plane or with the margin recurved and wavy, color "vinaceous tawny" with a paler margin at first, in age with a "vinaceous tawny" eyespot on the disc, the remainder white or tinged pinkish vinaceous, margin becoming lacerated, surface glabrous (very finely silky under a lens), often irregularly cracked; flesh moderately thick on the disc (1 mm. ±), white, pliant, when crushed having an odor of spoiled garlic, taste similar but not exceptionally strong; lamellae very crowded, many short individuals present, many forking or anastomosing, free or attached by a tooth, narrow (1 mm.), edges even, white, unchanging; stipe 3–5 cm. long, 1–2 mm. thick, equal or narrowed below, hollow, pliant, evenly covered by a coarse white tomentum, with a faint tinge of pinkish brown showing through near the base, base surrounded by a mass of white mycelium; pileus trama homogeneous, no differentiated surface layer present; cheilocystidia and pleurocystidia none; basidia four-spored; spores narrowly ellipsoid, 6–7 × 3 μ, smooth, not amyloid; gill trama and pileus trama yellow in iodine.

In clusters of three to four individuals or singly on fallen leaves, near Dexter, September 23, 1939 (no. 11056). It has also been found in the vicinity of Milford (no. 10947).

Kauffman (4) pointed out that the relationships of this species are with *Marasmius prasiosmus*. In the characters of the gills and spores as well as in the pubescence which covers the stipe and in its stature, *M. polyphyllus* appears to me to be more closely related to *M. urens*. The taste, though persistent, is not so pronounced as in other species with similar odors and tastes. There appears to be no reason for considering Marasmii with a garlic or onion-like taste and odor as forming a phylogenetic series.

Pleurotus mastrucatus (Fr.) Sacc. — Pileus 2–7 cm. broad, resupinate at first, becoming fan-shaped or spathulate, thick and fleshy, the upper half of the trama consisting of a gelatinous layer, the lower half white and floccose-filamentose, when young the surface covered by somewhat imbricate conic gelatinous

rigid spines, as expansion takes place the spines becoming separated from one another and remaining connected by raised lines giving the pileus a reticulate or netted appearance between projections, projections most numerous near the margin, white-villose or tomentose on or toward the base, margin long remaining inrolled, colors "dark Quaker drab" when young and fresh (with a distinct violet tinge), "light mouse-gray" or grayish white when very faded; lamellae white but becoming grayish, moderately broad (3–4 mm.), subdistant to close (5–8 tiers of short individuals), radiating from a point near the place of attachment to the substratum, edges cracking readily; stipe none; odor and taste slightly subnauseous; spores 7–8 × 4–5 μ, ellipsoid; pleurocystidia and cheilocystidia similar and abundant, 60–80 × 10–16 μ, originating in the subhymenium.

Imbricate on an old hickory log, near Dexter, October 18, 1939 (no. 14956). The collection was made by a group of mycological students. Kauffman included the species in his *Agaricaceae of Michigan* because it had been found in neighboring states. Apparently the 1939 record is the first one from Michigan.

Psilocybe atrobrunnea (Lasch) Gillet (Pl. III). — Although Kauffman included this species in his *Agaricaceae of Michigan*, his description does not contain certain details which are essential for the recognition of the fungus. For the past nine years I have collected the fungus quite regularly in bogs in the vicinity of Ann Arbor, and have made a detailed study of it. In the light of Favre's recent description of *Psilocybe turficola* (1), and specimens which have been received from Seth Lundell of Upsala, Sweden, under the name *P. dichroa* Karst., it seems pertinent to publish at this time a detailed account of the American fungus. The microscopic characters of Kauffman's specimens have been studied from the two collections preserved in the University of Michigan Herbarium. Furthermore, during the season of 1929 Kauffman personally checked the writer's identification. The following description has been drawn from fresh material collected at Mud Lake Bog, Whitmore Lake.

Pileus 1.5–4 (5.5) cm. broad, conic-campanulate, mammillate or convex, becoming plane or with an obtuse umbo, margin inrolled at first and faintly white-fibrillose from the remains of

a rudimentary veil, soon glabrous over all, surface viscid or subviscid with a thin subseparable gelatinous pellicle, color "carob brown," "Rood's brown," "Mars brown," or "Prout's brown" (sordid to bright cinnamon-brown) at first, usually blackish in age when wet, margin sometimes faintly pellucid striate, hygrophanous, fading to "cinnamon-buff" or darker and with a more or less ochraceous disc; flesh thickish, pliant and fairly tough, dark brown and watery at first, fading to "cinnamon-buff," odor faint and hardly distinctive, taste farinaceous; lamellae close, broad, adnate, soon seceding, pallid "cinnamon-buff" when young, dark purplish brown in age, edges white-fimbriate; stipe 8–18 cm. long, 2.5–6 mm. thick, equal and flexuous, stuffed by a white pith but soon hollow, cartilaginous and tough, at first more or less evenly covered with a coating of appressed-white fibrils up to the faint zone left by the rudimentary veil, apex pruinose, veil fibrillose and very distinct in button stages, surface dull grayish brown beneath the fibrils, in age becoming bister from the base upward; spores 9–11 (12.5) × 5–7 μ, with an apical hyaline germ pore, dark purplish brown in mass; basidia four-spored, occasionally two-spored; pleurocystidia scattered to abundant, 36–44 × 5–10 μ, ventricose near the base, with a slender tapered neck; cheilocystidia similar and very abundant, forming a sterile band on the edge of the gill; pileus trama homogeneous beneath a thin gelatinous pellicle.

Certain irregularities have been noticed among collections from the same swamp obtained at different times over a period of years. In no. 14944 the spores measure 8–10 × 5–6 μ. In collections previous to that one the spores measure 9–11 (13) μ long. In one of Kauffman's collections two-spored basidia are rather frequent, and the spores in my mounts from it measured 10–12 μ long, with some 13–16 μ. In addition to the variability of the spore size, pleurocystidia are sometimes very rare and difficult to locate because they are inconspicuous and scattered. Lundell, in a letter to me, commented upon this last character, so that it is apparent that a similar situation prevails in northern Europe.

Lange (6) has classified under the name *Psilocybe dichroa* Karst. a species which is probably identical with *P. squalidella*

Pk. Favre (1) believes that his *P. turficola* is identical with Kauffman's *P. atrobrunnea*. I am of the same opinion. European authors have apparently reserved the name *P. atrobrunnea* for a species with a radish-like odor. In all other respects, however, the descriptions of *P. atrobrunnea* agree remarkably well with those of American material. I question the advisability of placing much emphasis on the radish-like odor in this instance. I have found specimens of *Mycena glaericulata* with such an odor, but the character is not at all constant in that species. In *M. pura*, however, the opposite is true, as everyone knows. Many observations are desirable to establish an odor of this type as a reliable specific character. The size of the pileus as described for the fungus in Europe by no means excludes the American material. The outstanding macroscopic character of the species, and the one emphasized by the early descriptions, is the long, equal, flexuous, fibrillose stipe. In comparison with most of the early descriptions that of *P. atrobrunnea* covers the plant in question remarkably well. Since the name *P. atrobrunnea* is the oldest, it should be used in preference to any of the later ones.

University of Michigan

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Lactarius psammicola, sp. nov. × 1

Lepiota lenticularis (Lasch) Gillet. × 1

Psilocybe atrobrunnea (Lasch) Gillet. × 1

NOTES ON THE MARINE ALGAE OF TEXAS

WM. RANDOLPH TAYLOR

FIVE years ago in an article in the *Papers of the Michigan Academy of Science, Arts, and Letters* (Taylor, 1936) I included all the records of marine algae from Texas of which I was then aware. In the meantime three considerable collections of Texan marine algae and several smaller collections have come into my hands. Since they suffice to more than double the existing record of the marine flora it seems appropriate to list their contents and to direct attention to some of their more interesting features.

The earliest collection received consists of the marine algae preserved by Arthur Schott and loaned by the Field Museum of Natural History through the kindness of Dr. C. C. Gregg, the director, and of Dr. Francis Drouet, the curator of cryptogams. The collection contains about forty-five sheets of Texan algae, of which two thirds contribute to this account; the remaining algae either are unsuitable for study or, in a few instances, must be held until they are better understood. Schott, though chiefly concerned with flowering plants, was an omnivorous collector, and considerable numbers of marine algae which he assembled from other parts of North and South America are available for later study. It appears that during the period 1853-55 he was assistant to Major Emory in the Mexican Boundary Survey and besides performing his engineering duties collected plants and prepared some of the illustrations for the report of the survey (Emory, 1857). His Texan algal specimens are often small and poor, but they are very interesting and are exceeded in variety only by the most recent collections, made over seventy-five years later. They come chiefly from a place designated "Indianola" and shown in the map attached to the survey report as on the southwest shore of Matagorda Bay; the other station commonly mentioned is "Boca del Rio Bravo del Norte" — near the mouth of the Rio Grande, as it is now called. A few specimens are noted simply as from the "Gulf of Mexico," but they were collected during 1853, when Schott was in

Texas, and not in 1864–65, when he was in Yucatan, or later in 1865 when he was in Cuba, so that their Texan origin seems certain. The Schott algae were identified to some extent by their collector, but his names are commonly incorrect. With the specimens as mounted by the Field Museum are manuscript determinations made by W. G. Farlow. I have, however, confirmed or redetermined all that I report here.

The next collection in time of inception, a much larger one, is that assembled by Mr. Clyde T. Reed during the years 1928–39. It came from the southern part of the coast and adds considerably to the known flora. I am greatly indebted to Mr. Reed for the opportunity of studying this material.

The last of the larger collections is that made by Miss Beulah Smith; it was submitted to me for study by the kind intervention of Professor Frederick McAllister, of the University of Texas. This collection is particularly useful because it includes a number of northern stations and derives from more sources (about fifteen) than the others, which have a more restricted range.

In addition, I am indebted to Mr. Robert Runyeon, of Brownsville, for several specimens submitted and to the Field Museum and others for occasional sheets.

The material loaned by the Field Museum has naturally been returned there for deposit. Since that submitted by Miss Smith and Mr. Reed exists in duplicate, a part has been retained by the collectors and a part deposited in the Herbarium of the University of Michigan.

In listing these plants I have included the names reported in my earlier note (Taylor, 1936), that the account might be more complete, but it should be realized that a number of these were transcribed from the report ("O. S.," 1931) of M. A. Howe's determinations. So far as the new records are concerned, I am responsible for all the determinations.

As usual in early American algal collections, the stations given are often vague (though not ordinarily so vague as Schott's "Gulf of Mexico"), and sometimes they are so local as to defy discovery on general maps. In this paper the records are referred to the bay or island from which they came, or to the nearest large settlement. The approximate latitudes of the places mentioned are as follows: Texas City, 29° 20′; Galveston, 29° 15′; Palacios, 28° 45′; Lavaca

Bay, 28° 40′; Matagorda Bay, 28° 35′; Indianola, 28° 30′; Goose Island, 28° 10′; Copano Bay, Port Bay, and Aransas Bay, 28° 05′; Rockport, 28° 00′; Ransom Island, Port Aransas, and Aransas Pass, 27° 55′; Corpus Christi, Corpus Christi Bay, and Mustang Island, 27° 45′; Baffin Bay, 27° 15′; Padre Island, 27° 00′; Point Isabel and Brazos Santiago, 26° 10′; mouth of the Rio Grande, 25° 55′.

It is still too early to consider that the full character of the Texan marine flora is shown by the records, and additional species will, obviously, be brought to light. The impression strengthens, however, that the flora is a limited one, as determined by the sandy or muddy character of the shore line. These recent collections very markedly increase the representation of forms with tropical affinities. In the Chlorophyceae we find added *Acetabularia crenulata* and *Batophora Oerstedi;* in the Phaeophyceae, *Padina Vickersiae;* and in the Rhodophyceae, *Corallina cubensis, Jania capillacea, Chondria atropurpurea, Digenia simplex,* and others; on the east coast these plants are not known so far north as the Virginia capes. Outside of two or three species concerning the distribution of which little has been ascertained, all those reported from Texas are well known also from other stations much farther south. This seems to indicate that there is no marked North Temperate element in the flora and that it is composed of latitudinally wide-ranging species or of species only ranging south into the tropics. The dominant plants, such as the Enteromorphae, Ulvae, Gelidia, and Gracilariae, are clearly characteristic of relatively protected stations and known to be adaptable to reduced salinity. There are no species which are essentially reef plants, though *Laurencia papillosa* is certainly commonest on a reef or other rocky substrate.

List of Species

CHLOROPHYCEAE

ULVACEAE

Enteromorpha flexuosa J. Agardh. — Taylor 1928, p. 55, pl. 7, fig. 2. Rockport, Jan., 1936, *Reed;* Port Aransas, June, 1935, *Reed;* Corpus Christi, March, 1936, July, 1938, Feb., 1939, *Reed;* mouth of the Rio Grande, *Schott* no. 18 *p. p.*

ENTEROMORPHA LINGULATA J. Agardh. — Taylor 1936, p. 201. Indianola, Jan. and Feb., 1853, *Schott* nos. 9, 9a, 17a, 17b; Port Aransas, June, 1935, July, 1938, *Reed;* Corpus Christi Bay, May and June, 1937, *Smith;* Corpus Christi, July, 1938, *Reed;* Baffin Bay, Jan., 1936, *Reed;* Brazos Santiago, Sept., 1938, *Runyeon;* mouth of the Rio Grande, Oct. (and perhaps in other months), 1853, *Schott* nos. 10, 18 *p. p.*, 192, 197; same, April, 1939, *Runyeon.*

ENTEROMORPHA PLUMOSA Kützing. — Harvey 1871, pl. 263, as *E. Hopkirkii.* Lavaca Bay, June, 1937, *Smith;* Corpus Christi Bay, March, 1936, and June, 1937, *Smith;* Mustang Island, June, 1937, *Smith.*

ENTEROMORPHA PROLIFERA (Müller) J. Agardh. — Taylor 1928, p. 56, pl. 3, fig. 19; 1937, p. 65, pl. 3, fig. 2. Corpus Christi Bay, March and April, 1936, *Smith;* Corpus Christi, March, 1936, *Reed.*

ULVA FASCIATA Delile. — Taylor 1936, p. 202. Port Aransas, May, 1933, and July, 1935, *Reed;* Brazos Santiago, Sept., 1938, *Runyeon.*

ULVA LACTUCA L. — Taylor 1928, p. 57, pl. 3, figs. 20–21, pl. 7, fig. 7; 1936, p. 201; 1937, p. 75, pl. 4, fig. 6. Texas City, July, 1937, *Smith;* Galveston, 1878, Hb. F. M. N. H. nos. 797077, 797078; Palacios, Aug., 1937, *Smith;* Lavaca Bay, June, 1937, *Smith;* Matagorda Bay, June, 1937, *Smith;* Indianola, Feb., 1853, *Schott* no. 8 and also 1855, *Schott,* no number; Copano Bay, June and Aug., 1937, *Smith;* Rockport, March, 1932, *Reed;* Corpus Christi, Feb., 1934, and March, 1936, *Reed;* Corpus Christi Bay, Aug., 1937, *Smith.*

A good deal of this material tended toward var. *latissimum* (Linnaeus) De Candolle, of which Reed's no. 16 from Corpus Christi in 1934 is quite typical.

CLADOPHORACEAE

CHAETOMORPHA BRACHYGONA Harvey. — Taylor 1928, p. 60, pl. 4, fig. 12. Rockport, Aug., 1937, *Smith;* Port Aransas, March, 1937, *Sanders;* Corpus Christi Bay, Aug., 1937, *Smith;* Baffin Bay, Jan., 1936, *Reed.*

CHAETOMORPHA CLAVATA (C. Agardh) Kützing. — Børgesen 1913–20, II, p. 16. Brazos Santiago, Sept., 1938, *Runyeon.*

Chaetomorpha geniculata Montagne? — Fulton Bay, Aug., 1937, *Smith.*

Cladophora fascicularis (Mertens) Kützing. — Taylor 1928, p. 62; 1936, pp. 201, 202. Port Aransas, May, 1928 and 1932, and May, June, and July, 1935, *Reed;* Corpus Christi, March, 1936, and July, 1938, *Reed.*

Cladophora glaucescens (Griffiths ex Harvey) Kützing. — Harvey 1871, pl. 196; Taylor 1937, p. 86. Corpus Christi, July, 1938, *Reed.*

Cladophora variegata (C. Agardh) Zanardini. — "O. S." 1931, p. 26.

DASYCLADACEAE

Acetabularia crenulata Lamarck. — Taylor 1928, p. 67, pl. 5, figs. 11, 22–24. Copano Bay, Aug., 1937, *Smith;* Aransas Pass, June, 1935, *Reed;* Ransom Island, Aug., 1937, *Smith.*

Batophora Oerstedi J. Agardh, var. occidentalis (Harvey) Howe. — Taylor 1928, p. 68, pl. 5, figs. 1–2, 15–16. Port Bay, June and Aug., 1937, *Smith.*

PHAEOPHYCEAE

ECTOCARPACEAE

Ectocarpus confervoides (Roth) Le Jolis. — Taylor 1936, p. 202; 1937, p. 109, pl. 8, figs. 1–3. Corpus Christi, Feb., 1939, *Reed.*

Ectocarpus Duchassaignianus Grunow. — Taylor 1928, p. 107, pl. 14, fig. 3; 1936, p. 202.

Ectocarpus Mitchellae Harvey. — Harvey 1852–58, I, p. 142, pl. 12, fig. G; "O. S." 1931, p. 26.

Ectocarpus Rallsiae Vickers. — Vickers 1908, p. 44, pl. 32; "O. S." 1931, p. 26.

Ectocarpus siliculosus (Dillwyn) C. Agardh. — Taylor 1936, p. 201; 1937, p. 108, pl. 8, figs. 4–5. Corpus Christi, March, 1936, *Reed.*

DICTYOTACEAE

Padina Vickersiae Hoyt. — Taylor 1928, p. 123, pl. 17, fig. 9 Port Aransas, May, 1932, and June, 1935, *Reed.*

FUCACEAE

Sargassum Filipendula C. Agardh. — Taylor 1928, p. 127, pl. 18, fig. 5, pl. 19, fig. 17; 1937, p. 210, pl. 27, figs. 4–6. Mouth of the Rio Grande, *Schott* no. 34.

In these specimens the leaves are very narrow and forked; although serrate in the wider examples they are nearly entire in those which are narrowest; the stem is almost smooth. Both *S. cymosum* and *S. Filipendula* may develop forked leaves, especially on the basal shoots. The stem in *S. cymosum*, however, is commonly minutely muriculate, and the leaves, particularly the broad ones, entire, so that the plant no. 34 is hardly a form of *S. cymosum*. Var. *Montagnei* of *S. Filipendula* is suggested on the old labels, but it is defined as having long-apiculate bladders, which are lacking here; the receptacles of the present plant are, further, rather too compactly branched for that variety. It seems best left as a variant of the polymorphic *S. Filipendula*.

Sargassum fluitans Børgesen. — Taylor 1928, p. 127, pl. 18, fig. 9, pl. 19, fig. 5; 1936, p. 201. Mustang Island, July, 1937, *Smith;* Padre Island, June, 1935, *Reed;* mouth of the Rio Grande, Nov.—Dec., 1853, *Schott* no. 189, *p. p.;* same, April, 1939, *Runyeon.*

Sargassum natans (Linnaeus) Meyen. — Taylor 1928, p. 128, pl. 18, figs. 2–4, pl. 19, fig. 13; 1936, p. 202; 1937, p. 212. Near Point Isabel, 1930, *O'Malley,* Hb. F. M. N. H. no. 975641; mouth of the Rio Grande, Nov.—Dec., 1853, *Schott* no. 189, *p. p.*

Sargassum pteropleuron Grunow. — Taylor 1928, p. 130, pl. 18, fig. 6, pl. 19, fig. 13. Mustang Island, June, 1937, *Smith.*

RHODOPHYCEAE

BANGIACEAE

Bangia fuscopurpurea (Dillwyn) Lyngbye. — "O. S." 1931, p. 26; Taylor 1937, p. 218, pl. 28, figs. 10–12.

Goniotrichum Alsidii (Zanardini) Howe. — Taylor 1937, p. 215, pl. 28, figs. 1–4. On Laurencia, Corpus Christi, Feb., 1939, *Reed.*

CHANTRANSIACEAE

Acrochaetium crassipes Børgesen. — Børgesen 1913–20, II, p. 20. On Polysiphonia, Corpus Christi, Feb., 1939, *Reed.*

Acrochaetium virgatulum (Harvey) Bornet. — Taylor 1937, p. 230, pl. 31, figs. 4–7, a variety. Aransas Pass, June, 1934, *Reed.*

GELIDIACEAE

Gelidium corneum (Hudson) Lamouroux. — Greville 1830, p. 139, pl. 15, *p. p.;* Taylor 1928, p. 142, pl. 28, fig. 2; 1936, p. 201. Port Aransas, May, 1932, and June, 1934, *Reed;* same, March, 1937, *Sanders.*

Much of the Texas material of Gelidium, although probably ascribable to this species, is so narrow as hardly to appear flattened at all, and is very difficult to distinguish from some of the local forms called *G. crinale.* Because of this fact several specimens from other stations have not been listed.

Gelidium crinale (Turner) Lamouroux. — Taylor 1936, p. 202; 1937, p. 246, pl. 35, figs. 1–3, pl. 40, fig. 3, pl. 41, fig. 5. Galveston, June, 1937, *Smith;* Goose Island, Oct., 1937, *Smith;* Port Bay, Oct., 1937, *Smith;* Copano Bay, June, July, and Aug., 1937, *Smith;* Rockport, Jan., 1936, *Reed;* same, Sept., 1937, *Smith;* Port Aransas, May, 1932, and June, 1935, *Reed;* Aransas Bay, June, July, and Aug., 1937, *Smith;* Corpus Christi, June and Aug., 1936, 1937, *Smith;* same, July, 1938, and Feb., 1939, *Reed.*

Gelidium pusillum (Stackhouse) Le Jolis. — Taylor 1928, p. 142, pl. 20, fig. 8, pl. 22, fig. 9, pl. 23, fig. 3; "O. S." 1931, p. 26.

CORALLINACEAE

Corallina cubensis (Montagne) Kützing emend. Børgesen. — Børgesen 1913–20, II, p. 187; Taylor 1928, p. 205, pl. 29, fig. 12. Port Aransas, June, 1915, *Reed.*

Jania capillacea Harvey. — Taylor 1928, p. 206, pl. 29, figs. 2, 10. Ransom Island, Aug., 1937, *Smith.*

SOLIERIACEAE

Agardhiella tenera (J. Agardh) Schmitz. — Taylor 1928, p. 147, pl. 13, fig. 1; 1936, p. 202; 1937, p. 286, pl. 38, fig. 4, pl. 40,

fig. 7, pl. 41, fig. 2, pl. 59, fig. 9. "Gulf of Mexico," 1853, *Schott* no. 198; Galveston Bay, April, 1939, *Burt;* Indianola, 1855, *Schott*, no number, *p. p.;* mouth of the Rio Grande, Nov., 1853, *Schott* no. 190.

Eucheuma acanthocladum (Harvey) J. Agardh. — Taylor 1928, p. 148, pl. 31, fig. 1. "Gulf of Mexico," 1853, *Schott* no. 178, *p. p.*

HYPNEACEAE

Hypnea cervicornis J. Agardh. — Taylor 1928, p. 156, pl. 22, fig. 11; 1936, p. 201. Corpus Christi Bay, Aug., 1937, *Smith.*

Hypnea musciformis (Wulfen) Lamouroux. — Taylor 1928, p. 156, pl. 22, fig. 10, pl. 23, fig. 12; 1936, p. 202; 1937, p. 291, pl. 37, fig. 2. Port Aransas, June, 1933, and May, 1935, *Reed;* Aransas Pass, June, 1935, *Reed;* Aransas Bay, June, 1937, *Smith;* Corpus Christi Bay, Aug., 1937, *Smith;* Brazos Santiago, Sept., 1938, *Runyeon.*

GRACILARIACEAE

Gracilaria Blodgettii Harvey. — Taylor 1928, p. 151, pl. 23, fig. 9, pl. 33, fig. 6; "O. S." 1931, p. 26.

Gracilaria compressa (C. Agardh) Greville. — Harvey 1852–58, III, p. 108. "Gulf of Mexico," 1853, *Schott* no. 181.

Gracilaria confervoides (Linnaeus) Greville. — Taylor 1928, p. 152, pl. 23, fig. 10; 1937, p. 293, pl. 38, fig. 1. Galveston, Feb., 1854, *Schott*, no number; Indianola, Jan. and Feb., 1853, *Schott*, no number; Goose Island, July, 1935, *Reed;* Matagorda Bay, *Bailey*, Hb. F. M. N. H. no. 945315; same, June, 1937, *Smith;* Copano Bay, Sept., 1937, *Smith;* Rockport, June, 1935, *Reed;* Corpus Christi, March, 1930, *Benke* no. 5347; same, June, 1937, *Smith;* "Gulf of Mexico," 1853, *Schott* no. 187, *p. p.*

Gracilaria confervoides var. longissimus Harvey. — Harvey 1852–58, III, p. 108. Corpus Christi, July, 1938, *Reed.*

Gracilaria foliifera (Forsskål) Børgesen. — Taylor 1928, p. 155; 1936, p. 201, as *G. lacinulata;* 1937, p. 293, pl. 38, figs. 2, 3, pl. 41, fig. 1, pl. 59, fig. 7. Goose Island, July, 1935, *Reed;* Aransas Pass, June, 1935, *Reed;* Corpus Christi, July, 1938, *Reed.*

Gracilaria foliifera var. angustissima (Harvey) Taylor. — Taylor 1937, p. 294. Rockport, May, 1934, *Reed;* same, June

and Aug., 1937, *Smith;* Corpus Christi, March, 1936, *Reed;* Corpus Christi Bay, Aug., 1937, *Smith.*

GIGARTINACEAE

GIGARTINA ELEGANS Greville. — Brazos Santiago, Sept., 1938, *Runyeon.*

CERAMIACEAE

CENTROCERAS CLAVULATUM (C. Agardh) Montagne. — Taylor 1928, p. 189, pl. 28, figs. 6–7; 1936, pp. 201, 203. Indianola, Feb., 1854, *Schott,* no number, *p. p.,* and no. 25; Port Aransas, May and June, 1933, *Reed.*

CERAMIUM BYSSOIDEUM Harvey. — Taylor 1928, p. 190, pl. 27, figs. 20–21. Port Aransas, March, 1937, *Sanders;* Aransas Pass, June, 1934, *Reed;* Corpus Christi, Feb., 1939, *Reed.*

CERAMIUM STRICTUM (Kützing) Greville & Harvey. — Taylor 1937, p. 334, pl. 47, fig. 6, pl. 48, figs. 5–6, pl. 51, fig. 5. Indianola, Jan. and Feb., 1853, *Schott,* no number and nos. 34, 35.

CERAMIUM SUBTILE J. Agardh. — Taylor 1928, p. 192, pl. 27, figs. 17–19. Corpus Christi, July, 1938, *Reed.*

DASYACEAE

DASYA PEDICELLATA (C. Agardh) C. Agardh. — Taylor 1928, p. 173, pl. 35, fig. 7; 1937, p. 355, pl. 54, figs. 1–4. Indianola, Jan., 1853, *Schott* no. 6.

RHODOMELACEAE

BOSTRYCHIA MORITZIANA (Sonder) J. Agardh. — Taylor 1928, p. 166; 1936, p. 202; both as *Amphibia Moritziana,* syn.

BRYOCLADIA CUSPIDATA (J. Agardh) De Toni. — Taylor 1928, p. 168; 1936, p. 203. Port Aransas, May, 1932, *Reed;* Brazos Santiago, Sept., 1938, *Runyeon.*

CHONDRIA ATROPURPUREA Harvey. — Taylor 1928, p. 170. Corpus Christi, July, 1938, *Reed.*

DIGENIA SIMPLEX (Wulfen) C. Agardh. — Taylor 1928, p. 175, pl. 24, fig. 20, pl. 33, fig. 7. Indianola, Feb., 1853, *Schott,* no number; Rockport, Sept., 1937, *Smith;* Aransas Bay, May, 1936, June and Aug., 1937, *Smith;* Aransas Pass, June, 1935, *Reed;* Ransom Island, June, 1937, *Smith.*

Laurencia gemmifera Harvey. — Harvey 1852–58, III, p. 73, pl. 18b. Aransas Pass, June, 1935, *Reed;* same, May, 1936, *Smith;* Ransom Island, June, Aug., and Oct., 1937, *Smith.*

Laurencia papillosa (Forsskål) Greville. — Taylor 1928, p. 180, pl. 35, fig. 4. Rockport, June, 1937, *Smith;* Aransas Pass, June, 1935, *Reed.*

Laurencia Poitei (Lamouroux) Howe. — Taylor 1928, p. 181, pl. 34, figs. 4, 10. Corpus Christi, May, 1937, *Smith;* mouth of the Rio Grande, Nov., 1853, *Schott* no. 191.

Lophosiphonia subadunca (Kützing) Falkenberg. — Howe 1920, p. 574. Growing on Digenia, Aransas Pass, June, 1935, *Reed.*

Polysiphonia Binneyi Harvey. — Taylor 1928, p. 183. Port Aransas, March, *Sanders.*

Polysiphonia ferulacea Suhr. — Taylor 1928, p. 183, pl. 24, figs. 16–18, pl. 25, fig. 15, pl. 26, figs. 11, 15. Indianola, 1855, *Schott,* no number; Port Aransas, March, 1937, *Sanders.*

Wrightiella Tumanowiczii (Gatty) Schmitz. — Taylor 1928, p. 188, pl. 23, fig. 19; 1936, p. 203.

University of Michigan

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FLORA OF HACIENDA VISTA HERMOSA, NUEVO LEÓN

A MESOPHYTIC NONALKALINE HABITAT IN THE EASTERN SIERRA MADRE OF MEXICO *

STEPHEN S. WHITE

THIS paper is based on collections made in June, 1939, by Mr. L. H. Harvey and the writer at Hacienda Vista Hermosa, Nuevo León, 25 miles south of Monterrey, Mexico. Since only a limited time could be spent here, collecting was restricted to the oak zone, at an elevation of about 2,400 feet, well above the dry lowlands. An important feature of this place, and the one which seems to account for the luxuriance of the vegetation, is a permanent spring-fed stream, which at one spot plunges over a 100-foot precipice to form the well-known Horse-Tail Falls. The falls themselves are of botanical interest because of the thick deposits of travertine on the face and at the base of the precipice, formed by the action of blue-green algae.

The stream supports a narrow fringe of vegetation of decidedly northern aspect, which presents a striking contrast to the drier oak forests more typical of the region. The dominant species here are *Juglans mollis, Carya myristicaeformis,* and *Ulmus divaricata.* The elm is of interest because it was first described by Mueller from Diente Canyon, about twelve miles south of Monterrey.[1]

In some places these trees shade out practically all herbaceous vegetation except ferns. The species found were *Adiantum Capillus-Veneris, Anemia mexicana, Dryopteris concinna, D. Féei, Llavea cordifolia, Pteris cretica,* and *Tectaria heracleifolia.*

Growing in the stream itself, or in open places along its banks, were two interesting aroids, *Xanthosoma robustum* and *Arisaema*

* Papers from the Department of Botany and Botanical Gardens of the University of Michigan, No. 720.

[1] Mueller, C. H., "New and Noteworthy Trees in Texas and Mexico," *Bull. Torr. Bot. Club,* 63 : 147–155. 1936.

Dracontium. Other plants to be found in this walnut–hickory–elm association are *Salvia mexicana, Bassovia mexicana, Nama biflorum, Stellaria ovata, Anagallis arvensis, Spermacoce tenuior, Chiococca pachyphylla, Staphylea Pringlei, Phytolacca decandra, Scutellaria Seleriana, Cardamine auriculata, Linum cruciatum, Heimia salicifolia,* and *Sambucus mexicana.* A new species of Tragia was also discovered.

The vegetation of the oak forest proper closely resembled that of the corresponding zone of La Silla, which is described in the next paper, also by the writer. The collections made in the oak forest are included in the appended list.

The writer is indebted to Dr. I. M. Johnston for the determination of most of the specimens.

List of Species

Collection numbers are indicated in parentheses; those of L. H. Harvey are preceded by the letter H.

POLYPODIACEAE

Adiantum Capillus-Veneris L. (H–1036)
Dryopteris concinna (H. & B.) Kuntze (H–1060)
Dryopteris Féei C. Chr. (H–1084)
Llavea cordifolia Lag. (H–1033a)
Pteris cretica L. (H–1080)
Tectaria heracleifolia (Willd.) Underw. (H–1037)

SCHIZEACEAE

Anemia mexicana Kl. (H–1075)

SELAGINELLACEAE

Selaginella pilifera A. Br. (H–1033)

GRAMINEAE

Agrostis verticillata Vill. (H–1032, H–1034)
Andropogon saccharoides Swartz (H–1045, H–1066, H–1078)
Aristida spp. (H–1069, H–1076)
Bouteloua curtipendula (Michx.) Torr. (H–1071, H–1079)
Bouteloua filiformis (Fourn.) Griffiths (H–1077)
Bouteloua trifida Thurb. (H–1035)
Bromus texensis (Shear) Hitchc. (H–1040)
Cenchrus pauciflorus Benth. (H–1073)
Digitaria sanguinalis (L.) Scop. (H–1059, H–1067)
Eragrostis sp. (H–1064)
Hilaria mutica (Buckl.) Benth. (H–1034a)
Panicum fasciculatum Swartz (H–1046)
Panicum transiens Swallen (H–1058)

Paspalum conjugatum Bergius (H–1063)
Paspalum Langei Nash (H–1031, H–1039)
Paspalum lividum Trin. (H–1041)
Paspalum notatum Flügge (H–1047)
Paspalum unispicatum (Scribn. & Merr.) Nash (H–1074)
Piptochaetium fimbriatum (HBK.) Hitchc. (H–1038)
Setaria geniculata (Lam.) Beauv. (H–1070)
Sphenopholis obtusata (Michx.) Scribn. (H–1035a, H–1083)
Sporobolus Poiretii (R. & S.) Hitchc. (H–1043, H–1068)
Stipa mucronata HBK. (H–1042)
Trichachne californica (Benth.) Chase (H–1044)
Trichachne insularis (L.) Nees (H–1072)
Triodia texana S. Wats. (H–1048, H–1065)

ARACEAE

Arisaema Dracontium (L.) Schott (1512)
Xanthosoma robustum Schott (1639)

BROMELIACEAE

Tillandsia usneoides L. (1560)

FAGACEAE

Quercus Canbyi Trelease (1545, 1601)
Quercus polymorpha C. & S. (1600, 1609)

JUGLANDACEAE

Carya myristicaeformis (Michx.) Nutt. (1629)
Juglans mollis Engelm. (1633)

URTICACEAE

Parietaria debilis Forst. (1567)
Pilea microphylla (Sw.) Liebm. (1548)

ULMACEAE

Ulmus divaricata C. H. Muell. (1637)

AMARANTHACEAE

Amaranthus hybridus L. (1592)

PHYTOLACCACEAE

Phytolacca decandra L. (1511)
Rivina humilis L. (1558)

CARYOPHYLLACEAE

Stellaria ovata Willd. (1517)

RANUNCULACEAE

Clematis Drummondii T. & G. (1570)

PAPAVERACEAE

Argemone mexicana L. (1642)

CRUCIFERAE

Cardamine auriculata Wats. (1521)
Lepidium virginicum L. (1619)
Lepidium virginicum var. *pubescens* (Greene) C. L. Hitchc. (1641)

LEGUMINOSAE

Cercis canadensis L. (1538)
Galactia striata (Jacq.) Urban (1627)
Indigofera brevipes (Wats.) Rydb. (1585)
Medicago lupulina L. (1541)
Mimosa malacophylla Gray (1607)

LINACEAE

Linum cruciatum Planch. (1524)

RUTACEAE

Decatropis bicolor (Zucc.) Radlk. (1603)

MELIACEAE

Melia Azedarach L. (1565)

EUPHORBIACEAE

Acalypha phleoides Cav. (1559)
Croton sp. (1553)
Euphorbia spp. (1547, 1556)
Tragia sp., sp. nov. (1535)

ANACARDIACEAE

Rhus Toxicodendron L. (1543)

SAPINDACEAE

Sapindus Saponaria L. (1605)
Ungnadia speciosa Endl. (1604)

ACERACEAE

Acer Negundo L. (1638)

STAPHYLEACEAE

Staphylea Pringlei Wats. (1510)

RHAMNACEAE

Colubrina Greggii Wats. (1549)

VITACEAE

Vitis Berlandieri Planch. (1614)

MALVACEAE

Malvastrum coromandellianum (L.) Garcke (1613)
Sida procumbens Sw. (1532)

LYTHRACEAE

Cuphea procumbens Cav. (1615)
Heimia salicifolia (HBK.) Link (1528)

ONAGRACEAE

Gaura sinuata Nutt. (1635)
Oenothera rosea Ait. (1564, 1636)

UMBELLIFERAE

Sanicula mexicana DC. (1526)

PLUMBAGINACEAE

Plumbago scandens L. (1561)

PRIMULACEAE

Anagallis arvensis L. (1518)
Samolus floribundus HBK. (1550)

CONVOLVULACEAE

Cuscuta indecora neuropetala (Choisy) Hitchcock (1611)
Evolvulus alsinoides L. (1575)
Ipomoea hirsutula Jacq. (1599)

POLEMONIACEAE

Gilia incisa Benth. (1554, 1572, 1573)

HYDROPHYLLACEAE

Nama biflorum Choisy (1515)

BORAGINACEAE

Ehretia anacua (Berland.) Johnston (1602)

VERBENACEAE

Lantana achyranthifolia Desf. (1569)
Lantana Camara L. (1537)
Lippia reptans HBK. (1587)
Priva mexicana (L.) Pers. (1566)

Verbena canescens HBK. (1571)
Verbena ciliata Benth. (1576)
Verbena Halei Small (1542, 1577)

LABIATAE

Hedeoma Drummondii Benth. (1563, 1618)
Salvia coccinea L. (1574)
Salvia mexicana L. (1513)
Scutellaria Seleriana Loes. (1516)
Teucrium cubense L. (1552)

SOLANACEAE

Bassovia mexicana Robins. (1514)
Capsicum baccatum L. (1606)
Physalis viscosa L. (1612)
Solanum nigrum L. aff. (1557)

ACANTHACEAE

Ruellia Parryi Gray (1579)
Ruellia tuberosa L. (1598)
Siphonoglossa pilosella (Nees) Torr. (1578)
Tetramerium hispidum Nees (1610)

CAPRIFOLIACEAE

Sambucus mexicana Presl. (1523)

RUBIACEAE

Bouvardia ternifolia (Cav.) Schlecht. (1616)
Chiococca pachyphylla Wernh. (1509)
Randia laetivirens Standley (1544)
Spermacoce tenuior L. (1562)

COMPOSITAE

Actinea linearifolia (Hook.) Kuntze (1582)
Astranthium integrifolium (Michx.) Nutt. (1527)
Calyptocarpus vialis Less. (1520)
Dyssodia Berlandieri (DC.) Blake (1630)
Eupatorium odoratum L. (1593)
Gaillardia mexicana Gray (1634)
Helenium amphibolum Gray (1530)
Heterotheca chrysopsidis DC. (1581)
Sclerocarpus uniserialis Benth. & Hook. (1589)
Selloa glutinosa Spreng. (1580, 1640)
Stevia Berlandieri Gray (1626)
Tetragonotheca texana Engelm. & Gray (1583)
Vernonia Ervendbergii Gray (1551, 1628)
Wyethia mexicana Wats. (1624)

University of Michigan

VEGETATION OF CERRO DE LA SILLA, NEAR MONTERREY, MEXICO *

STEPHEN S. WHITE

THE present paper is based on three weeks' collecting by Mr. Roy M. Chatters and the writer in August and September, 1937, and on additional collections made by Mr. L. H. Harvey and the writer in the latter part of June, 1939.

CLIMATE

The altitude of Monterrey, capital of the state of Nuevo León, is 528 meters or 1,624 feet. Available meteorological data indicate that extremes of climate are not great (1). The average temperature ranges from a low of 13° C. in December to a high of 28.4° C. in August, and the extremes reported are a maximum of 40° C. and a minimum of − 5° C. Rainfall occurs throughout the year, but is most abundant in September and October, for which an average precipitation of 184 mm. (7.5″) and 115 mm. (4.5″) respectively are recorded. The remainder of the annual precipitation, 648 mm. (25.5″), is distributed among the other ten months, with January receiving only 5.2 mm. and June 64.8 mm. The average annual relative humidity is approximately 63 per cent. These data, based on observations during the five-year period 1921–25, give perhaps a good impression of the general nature of the climate, although such a period is too short to provide entirely trustworthy averages. Indeed, it seems very likely that the climate does not differ materially from that of Laredo, Texas, since the higher altitude compensates for the more southerly latitude.

GEOLOGY

The Sierra de la Silla, extending southeastward from Monterrey, is abruptly terminated at its northern end, just outside the city itself, in the well-known Cerro de la Silla, so named because of its saddle-

* Papers from the Department of Botany and Botanical Gardens of the University of Michigan, No. 717.

like appearance (Pl. I). The peaks rise some 3,500 feet above the plain, which extends northeastward from Monterrey to the valley of the Rio Grande.

Although accessibility is not a problem here, as it is in many other parts of Mexico, scarcely any geological work done in this region has been reported. It has been stated, however, that the rocks are thick-bedded reef limestones of the lower Cretaceous, and the general structure of the region is anticlinal. The surrounding territory is highly mineralized, and a number of mines have been operated here in the past.

HISTORY

References to previous botanical work in this area are found scattered in reports on the collections made in southern Texas and northern Mexico. The first botanist to enter the territory was L. Berlandier, who was commissioned by the Mexican government to report on the nature of the country along the northern border of Mexico (2). The expedition of which Berlandier was a member arrived in Monterrey on January 7, 1828. Two weeks were spent there. His description of the vegetation is made in quite general terms, for he found most of it dormant at that season. He states that he saw in flower, however, many legumes, some composites, a species of Buddleia, a jimson weed, and *Canna indica.* Among cultivated plants growing around Monterrey he mentions cotton, sugar cane, corn, which is harvested twice a year, oranges, limes, and other fruits.

Berlandier was followed by A. Wislizenus and J. Gregg, who accompanied the Doniphan expedition from Chihuahua to Monterrey and back to the United States in 1847 (4). After that time a dozen or more botanists worked near Monterrey. Some of these were Palmer, Parry, Eaton, Edwards, C. and E. Seler, Rose, Canby, and Nelson. Pringle, the best known of all collectors in Mexico, began his extensive travels in 1885, but did not collect near Monterrey until three years later (3). Between 1888 and 1908 he visited Monterrey about eight times to add to his collections.

DESCRIPTION OF THE VEGETATION

At the foot of La Silla there is a small intermittent stream, which at the time of our visits contained only a few pools of water. The course of the stream could be followed in the distance by the trees

which lined its banks. These were *Taxodium mucronatum, Platanus mexicana, Pithecolobium flexicaule,* and *Celtis laevigata.* Most of the herbaceous vegetation was found along the margins of the pools or growing on the dry bottom of the stream. Grasses and sedges were much more abundant here than elsewhere. The grasses, some of them mere weeds, were *Cynodon Dactylon, Paspalum Langei, P. pubiflorum, P. lividum, P. conjugatum, Setaria lutescens, S. geniculata, Echinochloa colonum, Bouteloua filiformis, B. trifida, Triodia texana, T. pilosa, Sorghum halapense, Cenchrus pauciflorus, Aristida Roemeriana, Leptoloma cognatum, Agrostis verticillata,* and *Chloris ciliata.*

Other prominent elements of the vegetation were *Clematis Drummondii, Solanum elaeagnifolium, Ipomoea hirsutula, Nicotiana glauca, Heliotropium procumbens, Lippia reptans, Hydrocotyle verticillata, Baccharis glutinosa, Helenium amphibolum, H. heterophyllum,* and *Tridax procumbens.*

The lower slopes of La Silla are characterized by a growth of microphyllous trees and shrubs which form impenetrable thickets in many places. Here legumes are common, although the number of species is not great. *Caesalpinia caladenia, Acacia Coulteri, A. Farnesiana, A. amentacea,* and *Parosela hospes* are the most common members of the Leguminosae. These, together with the representatives of a number of other families, such as *Cordia Boissieri, Helietta parvifolia, Karwinskia Humboldtiana, Chiococca pachyphylla, Leucophyllum texanum, Ehretia Anacuna,* and *Bouwardia ternifolia,* constitute the dominant vegetation of this zone. The average height of these species probably does not exceed three meters. Although herbaceous plants were here very scarce, low scandent or woody plants were rather common. The most conspicuous of these, in some places at least, was *Mascagnia macroptera.* Lantana was also common; it was represented by four or more species. Other characteristic plants of this zone were *Dyssodia pentachaeta, Vernonia Ervendbergii, Siphonoglossa ramosa, Tetramerium hispidum, Ruellia tuberosa, Jatropha spathulata, Croton monanthogynus,* and *C. fruticulosus.*

Cacti of the pincushion type were abundant in this zone, especially on the ledges formed by the outcropping of the underlying limestone. We secured for propagation in the Botanical Gardens specimens of Mammillaria, Echinocereus, Epithelantha, and Escobaria. Larger forms such as Opuntia were not common.

This type of vegetation extended up the mountain to an elevation of some 3,000 feet. Agaves and similar plants and the palm, *Brahea Berlandieri*, are additional elements of the flora at this elevation (Pl. II, Figs. 1–2). The palm extends some distance into the adjacent oak forest. Among the other plants growing here, but not found at lower elevations, were *Decatropis bicolor*, *Polanisia uniglandulosa*, *Houstonia tenuifolia*, *Cocculus carolinus*, *Cassia Lindheimeriana*, *Sophora secundiflora*, *Bocconia latisepala*, and *Mirabilis Jalapa*.

The upper half of the mountain is mostly covered with a rather dense forest, consisting mainly of three species of oak: *Quercus Canbyi*, *Q. monterreyensis*, and *Q. fusiformis*. The conditions in this forest present a striking contrast to those on the lower slopes. Although scarcely any rain fell during the period in which the collections were being made, it was evident that the upper part of the mountain was more abundantly supplied with water than the lower part. This was doubtless due, in part at least, to the fact that the upper regions were almost daily enveloped in dense cloud banks, especially in the early morning. The most noticeable effect of the relative abundance of water was the luxuriant growth of mosses and ferns. The mosses formed a thick carpet over the rocks and canyon walls, and the ferns, although there were but few species, were plentiful. The species found were *Polypodium polypodioides*, *P. plesiosorum*, *P. guttatum*, *Phanerophlebia umbonata*, *Llavea cordifolia*, *Asplenium resiliens*, *Cheilanthes alabamensis*, and *C. castanea*. *Selaginella cuspidata* and *S. pilifera* were also collected here.

In the oak forest there was a minor element of woody plants made up of *Bauhinia lunarioides*, *Staphylea Pringlei*, *Garrya ovata*, *Vitis Berlandieri*, *Rhamnus serrata*, *Ungnadia speciosa*, *Tilia floridana*, and *Ptelea trifoliata*. Herbaceous vegetation in the deepest part of the forest was almost entirely absent, for only *Parietaria debilis*, *Urtica chamaedryoides*, and *Allium scaposum* were found; in open places, however, the herbaceous flora was well diversified. At the top of the mountain, between the two peaks where the oak forest did not reach, we found dense carpets of *Sedum diffusum*, *Omphalodes acuminata*, and *Lobelia Cliffortiana*. Other prominent plants were *Linum medium*, *Scutellaria suffrutescens*, *Hypericum sp.*, *Erysimum asperrimum*, *Geranium mexicanum*, *Oxalis madrensis*, *Nama biflorum*, *Verbesina coahuilensis*, *Chrysopsis villosa*, *Senecio montereyanus*, and *Encelia sp.* The woody plants were all low shrubs of the following

species: *Philadelphus Coulteri, Eysenhardtia texana, Colubrina Greggii,* and *Bauhinia lunarioides.* It is of interest to note that the palm *Brahea Berlandieri,* which is common below the oak zone, was also present at the top of the mountain. The elevation at this point between the peaks is 5,200 feet.

Although an attempt was made to collect as large a representation of the flora as possible, the results certainly do not justify any claim that the work has been completed. However, in view of the fact that increasing numbers of botanists are becoming interested in Mexico, it is believed worth while to publish something on what has been accomplished to date, especially since there is no immediate prospect of continuing the work.

All material is deposited in the herbarium of the University of Michigan, with partial duplicate sets in the Gray Herbarium of Harvard University, and in the herbarium of the Instituto de Biología, México, D. F., and the personal herbarium of Dr. Forrest Shreve.

ACKNOWLEDGMENTS

The writer is deeply grateful to Dr. I. M. Johnston for the determination of most of the 1939 collections. For other determinations his indebtedness is as follows: oaks, by Dr. C. H. Mueller; cacti, by Dr. Elzada U. Clover; grasses, by Mr. L. H. Harvey; a miscellaneous group of plants, by Dr. J. W. Moore. Special thanks are due to Professor H. H. Bartlett for much valuable assistance in the preparation of the manuscript.

List of Species

Collection numbers are indicated in parentheses; those of L. H. Harvey are preceded by the letter H.

POLYPODIACEAE

Adiantum tricholepis Fée (82)
Asplenium resiliens Kuntze (H–989)
Cheilanthes alabamensis (Buckl.) Kuntze (H–984, H–990)
Cheilanthes castanea Maxon (H–994, H–995)
Cheilanthes spp. (86, H–1019)
Llavea cordifolia Lag. (152)
Notholaena sinuata (Lag.) Kuntze (H–1012)
Phanerophlebia umbonata Underw. (27, H–996)
Polypodium guttatum Maxon (156, H–992)
Polypodium plesiosorum Kuntze (34)
Polypodium polypodioides (L.) Watt. (20, 22, H–991, H–1016)

SELAGINELLACEAE

Selaginella cuspidata Link (H–997)
Selaginella pilifera A. Br. (H–1018)
Selaginella spp. (H–983, H–988)

PINACEAE

Taxodium mucronatum Ten. (44, 1421)

GRAMINEAE

Agropyron spicatum (Pursh) Scribn. & Smith (H–1013, H–982)
Agrostis verticillata Vill. (H–971, H–977)
Aristida Roemeriana Schult. (H–960, H–968)
Aristida sp. (H–979)
Bouteloua filiformis (Fourn.) Griffiths (H–952, H–972a, H–980)
Bouteloua trifida Thurb. (H–954)
Brachypodium Pringlei Scribn. (H–999)
Bromus spp. (H–985, H–987, H–998)
Cenchrus pauciflorus Benth. (H–967)
Chloris ciliata Swartz (H–976)
Cynodon Dactylon (L.) Pers. (160, H–955)
Echinochloa colonum (L.) Link (187)
Leptoloma cognatum (Schult.) Chase (H–958)
Melica Montezumae Piper (H–981)
Muhlenbergia longiligula Hitchc. (H–986)
Paspalum conjugatum Bergius (H–970)
Paspalum Langei (Fourn.) Nash (167, H–978, H–1028a)
Paspalum lividum Trin. (H–974)
Paspalum pubiflorum Rupr. (188, H–957)
Setaria geniculata (Lam.) Beauv. (H–956a, H–973)
Setaria lutescens (Wiegel) F. T. Hubb (186)
Sorghum halapense (L.) Pers. (H–969)
Triodia pilosa (Buckl.) Merr. (H–966)
Triodia texana S. Wats. (H–953, H–959)

CYPERACEAE

Cyperus sp. (1498)
Eleocharis capitata (L.) R. Br. (70)

COMMELINACEAE

Commelina sp. (1415)

PALMACEAE

Brahea Berlandieri Bartlett (31)

ARACEAE

Xanthosoma robustum Schott (185)

LILIACEAE

Allium scaposum Benth. (29)
Dasylirion sp. (1621)

AMARYLLIDACEAE

Agave sp. (1643)

FAGACEAE

Quercus Canbyi Trelease (33)
Quercus fusiformis Small (1462)
Quercus monterreyensis Trel. & Muell. (1487)

ULMACEAE

Celtis laevigata Willd. (184, 1429)

URTICACEAE

Parietaria debilis Forst. (1489)
Urtica chamaedryoides Pursh (1490)

POLYGONACEAE

Polygonum sp. (180)

AMARANTHACEAE

Amaranthus spinosus L. (63)

NYCTAGINACEAE

Boerhaavia caribaea Jacq. (114)
Mirabilis Jalapa L. (149)

PORTULACCACEAE

Talinum lineare HBK. (1623)
Talinum reflexum Cav. (1622)

PHYTOLACCACEAE

Phytolacca decandra L. (140)
Rivina humilis L. (118)

RANUNCULACEAE

Clematis Drummondii T. & G. (129, 168, 171)

MENISPERMACEAE

Cocculus carolinus (L.) DC. (122)
Cocculus diversifolius DC. (1493)

PAPAVERACEAE

Argemone mexicana L. (1506)
Bocconia latisepala Wats. (151)

CRUCIFERAE

Erysimum asperrimum (Greene) Rydb. (1475)
Lepidium virginicum L. (1441)

CAPPARIDACEAE

Polanisia uniglandulosa (Cav.) DC. (107)

CRASSULACEAE

Sedum diffusum Wats. (1466)

SAXIFRAGACEAE

Fendlera linearis Rehder (1483)
Philadelphus Coulteri Wats. (1470)

PLATANACEAE

Platanus mexicana Moric. (157, 1448)

LEGUMINOSAE

Acacia amentacea DC. (1418)
Acacia Coulteri Benth. (8)
Acacia Farnesiana (L.) Willd. (1417)
Bauhinia lunarioides Gray (32, 1473)
Caesalpinia caladenia Standl. (7)
Cassia Greggii Gray (191)
Cassia Lindheimeriana Scheele (133)
Cassia occidentalis L. (40)
Eysenhardtia texana Scheele (1476)
Parosela hospes Rose (26, 144)
Pithecolobium flexicaule (Benth.) Coulter (36)
Sophora secundiflora (Ortega) Lag. ex DC. (105, 1492)

GERANIACEAE

Geranium mexicanum HBK. (141)

OXALIDACEAE

Oxalis Leonis R. Kunth (125)
Oxalis madrensis Wats. (146)

LINACEAE

Linum medium (Planch.) Britton (145, 1479)

RUTACEAE

Decatropis bicolor (Zucc.) Radlk. (1463)
Helietta parvifolia (Gray) Benth. (2)
Ptelea trifoliata L. (1469)

MALPIGHIACEAE

Malpighia glabra L. (84a)
Mascagnia macroptera (Moc. & Sessé) Niedenzu (3, 1408)

EUPHORBIACEAE

Acalypha dioica Wats.? (68)
Acalypha sp. (11)
Croton ciliato-glandulosus Ort. (1432)
Croton fruticulosus Engelm. (102, 128)
Croton monanthogynus Michx. (93)
Euphorbia pilulifera L.? (1413)
Jatropha spathulata (Ortega) Muell. (6, 1644)
Ricinus communis L. (41, 1405)

SAPINDACEAE

Dodonaea viscosa Jacq. (100, 1647)
Ungnadia speciosa Endl. (1491)

STAPHYLEACEAE

Staphylea Pringlei Wats. (1488)

RHAMNACEAE

Colubrina Greggii Wats. (15, 1472, 1503)
Karwinskia Humboldtiana (Roem. & Schult.) Zucc. (5, 18)
Rhamnus serrata Willd. (1485)

VITACEAE

Vitis Berlandieri Planch. (1486)

TILIACEAE

Tilia floridana Small (1482)

MALVACEAE

Hibiscus cardiophyllus Gray (97)
Sida spinosa L. (99)

STERCULIACEAE

Hermannia texana Gray (1507)

HYPERICACEAE

Hypericum sp. (1474)

FLACOURTIACEAE

Xylosma Pringlei Rob. (111)

PASSIFLORACEAE

Passiflora foetida L. (172)

RUBIACEAE

Bouvardia ternifolia (Cav.) Schlecht. (123, 1460)
Cephalanthus occidentalis L. (71)
Chiococca pachyphylla Wernham (12)
Galium sp. (1414)
Houstonia tenuifolia Nutt. (108)
Randia Watsoni Robinson (10, 1464)

LOBELIACEAE

Lobelia Cliffortiana L. (138, 1480)
Lobelia splendens Willd. (37)

COMPOSITAE

Baccharis glutinosa Pers. (39, 192)
Chrysopsis villosa (Pursh) DC. (132, 1471)
Dyssodia pentachaeta (DC.) Robins. (87, 1508)
Eclipta alba (L.) Hassk. (65)
Encelia sp. (9)
Eupatorium coelestinum L. (194)
Eupatorium odoratum L. (1433)
Gutierrezia eriocarpa Gray (179)
Helenium amphibolum Gray (1445, 1447)
Helenium heterophyllum DC. (1412, 1446, 1449)
Heterotheca sp. (190)
Heterotheca subaxillaris (Lam.) Britt. & Rusby (62)
Parthenium hysterophorus L. (1411)
Selloa glutinosa Spreng. (127)
Senecio montereyanus Wats. (1477)
Tetragonotheca texana Engelm. & Gray (1504)
Tridax procumbens L. (54, 1416, 1444, 1505)
Verbesina coahuilensis Gray (1467)
Vernonia Ervendbergii Gray (121)
Zexmenia hispida (HBK.) Gray (1501)

University of Michigan

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View of La Silla from Monterrey (photograph by E. E. Barros)

FIG. 1. Vegetation a little below oak forest

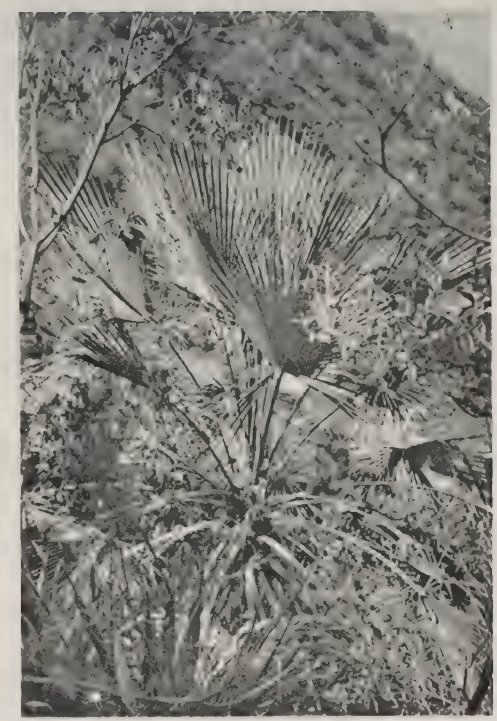

FIG. 2. *Brahea Berlandieri* Bartlett

SEED GERMINATION AND SEEDLING ANATOMY OF SNAPDRAGON (*ANTIRRHINUM MAJUS* L.)

EDWARD F. WOODCOCK

A SURVEY of the literature on *Antirrhinum majus* L. gives no information concerning seed germination and seedling anatomy. Normal cytological processes have been observed in the embryo sac in snapdragon by Propach (2), and Klemm (1) has noted the axile placentation. The morphology of the seed has been described by the writer (3). This paper has to do with a study of some of the tissue changes in seed germination and seedling development of *Antirrhinum majus* L.

MATERIAL AND METHODS

The seeds were germinated in the greenhouse. An interpretation of the changes which occur in the seedling development was obtained by an examination of microtome sections stained with Delafield's haematoxylin. A check on the course of the vascular bundles was gained by observing cleared seedlings.

GERMINATION AND SEEDLING ANATOMY

A brief description of the mature seed will aid in understanding the changes which occur in the early stages of germination. The seed coat consists almost entirely of a single layer of epidermal cells. This uncrushed layer is all that remains of the integument and nucellus. There arise from the outer wall of this layer hairlike outgrowths which are arranged as interconnected ridges. The embryo is a typical dicot type, straight and centrally placed in the starchy endosperm.

In the process of germination the radicle lengthens rapidly to form the primary root. It emerges from the seed through a break in the seed coat, and soon elongates and becomes established in the soil (Pl. I, Fig. 3). The primary meristem regions in the primary root tip are very well marked (Pl. I, Figs. 1–2). The tip of the root is protected by a well-developed rootcap (Pl. II, Fig. 9). The cells of

the dermatogen are distinct from the underlying layer and vary in their tangential dimension. The outer wall of each cell is bulged outward. The periblem is composed of two layers of cells, which are larger than the dermatogen cells and between which occur intercellular spaces. The plerome consists of a peripheral layer of large cells and a central region of small cells.

As germination proceeds further the cotyledons separate from the seed coat and the hypocotyl elongates, which brings the two cotyledons above the soil. The primary root soon produces lateral roots, and the plumule, at the base of the cotyledons, differentiates into a stem bearing opposite leaves.

Numerous anatomical changes occur in the differentiation of the embryo into the seedling. The peripheral cells of the plerome in the root produce a distinct endodermis layer, which later becomes less conspicuous. The central cells of the plerome form the pericycle and the diarch radial bundle (Pl. II, Fig. 1). The pericycle is not easily distinguished from the phloem of the bundle. In the transition region between the primary root and the hypocotyl the vascular tissue becomes so oriented that there are two open collateral bundles in the hypocotyl (Pl. I, Fig. 4; Pl. II, Fig. 4). The course of the vascular bundles through the hypocotyl and the organs above the hypocotyl is diagrammatically shown (Pl. II, Fig. 4). Each of the hypocotyl bundles sends off a branch to each of the cotyledons (Pl. I, Fig. 5). A short distance above these opposite branches each of the hypocotyl bundles again sends off two opposite branches (Pl. I, Fig. 6), which extend for a short distance into the internode between the cotyledon node and first leaf node (Pl. I, Fig. 7). In the base of the internode each of these branches divides again, and a fusion of four of the branches occurs, as shown in the terminal portion of the lower segment of the diagram (Pl. II, Fig. 4). As a result there are eight bundles in the part of the internode directly below the leaf node (Pl. I, Fig. 8). The two bundles which pass out to the petiole of each of the opposite leaves are a continuation of the hypocotyl bundles and divide into three parts as they enter each petiole. Four of the branches, formed in the base of the internode, above the cotyledons, again divide in the leaf node, so that in the internode above the first leaf node there are ten bundles (Pl. I, Fig. 9).

The epidermis of the seedling in the parts above the ground produces gland-tipped and pointed hairs ranging from two to several

cells in length (Pl. II, Fig. 3). Those of the former type are quite generally distributed, whereas those of the latter are not found to any extent on the cotyledons and leaves.

The first leaves (Pl. II, Fig. 7) are oval, and the three bundles in the petiole divide in the blade to form a closely interconnected system of veins. The blade is thin and consists of large loosely arranged mesophyll cells (Pl. II, Fig. 5). The cells of the palisade region differ only slightly from those of the spongy region. Those of the lower and upper epidermis are similar in shape and their radial walls are sinuous in outline when the flat surface of the epidermis is observed (Pl. II, Fig. 2). In the lower epidermis there are typical stomata.

The cotyledons are almost circular in outline, and the two vascular bundles which enter the blade divide to form a system of anastomosing veins (Pl. II, Fig. 8). The epidermis of the cotyledon is similar to that of the leaves, and there is very little evidence of a distinct palisade and spongy region in the mesophyll.

The primary vascular bundles of the hypocotyl and stem consist of phloem, indistinct cambium, and xylem (Pl. II, Fig. 6). The phloem is made up of sieve tubes, companion cells, and parenchyma. The xylem consists of ringed and spiral tracheary tubes and parenchyma. Very little collenchyma and no fibers are present in the hypocotyl and stem of the seedling.

SUMMARY

The seedling produced as a result of the germination of the snapdragon seed has a diarch radial bundle in the root and two open collateral bundles in the hypocotyl. Branching of the bundles occurs in the cotyledon node, resulting in two bundles to each cotyledon and eight bundles in the internode above the cotyledons. Further branching occurs in the region of the first leaf node, and thus forms three bundles to each leaf and ten bundles in the internode above the first leaf. The primary meristems are very distinct in the root tip. Gland-tipped and pointed hairs occur on the parts of the seedling above the ground. The radial walls of the epidermis of the leaves and cotyledon are sinuous in outline. The mesophyll is loosely arranged. The collateral vascular bundles in the stem have no well-marked cambium region.

Michigan State College
East Lansing, Michigan

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PLATES I–II

NOTE

Seedling of *Antirrhinum majus* L.

Figure 4, Plate I, is a diagram. All other figures are drawn with aid of camera lucida. The following abbreviations are used: C, cambium; D, dermatogen; EN, endodermis; EP, epidermis; P, periblem; PA, parenchyma; PE, palisade region; PH, phloem; PL, plerome; R, rootcap; S, spongy region; ST, stoma; T, tracheary tube; W, pericycle.

EXPLANATION OF PLATE I

FIG. 1. Cross section of root tip, showing dermatogen, periblem, and plerome. × 60

FIG. 2. Longitudinal section of root tip. × 28

FIG. 3. Longitudinal section of seedling and seed. × 12

FIG. 4. Cross section of hypocotyl, showing the two vascular bundles. × 18

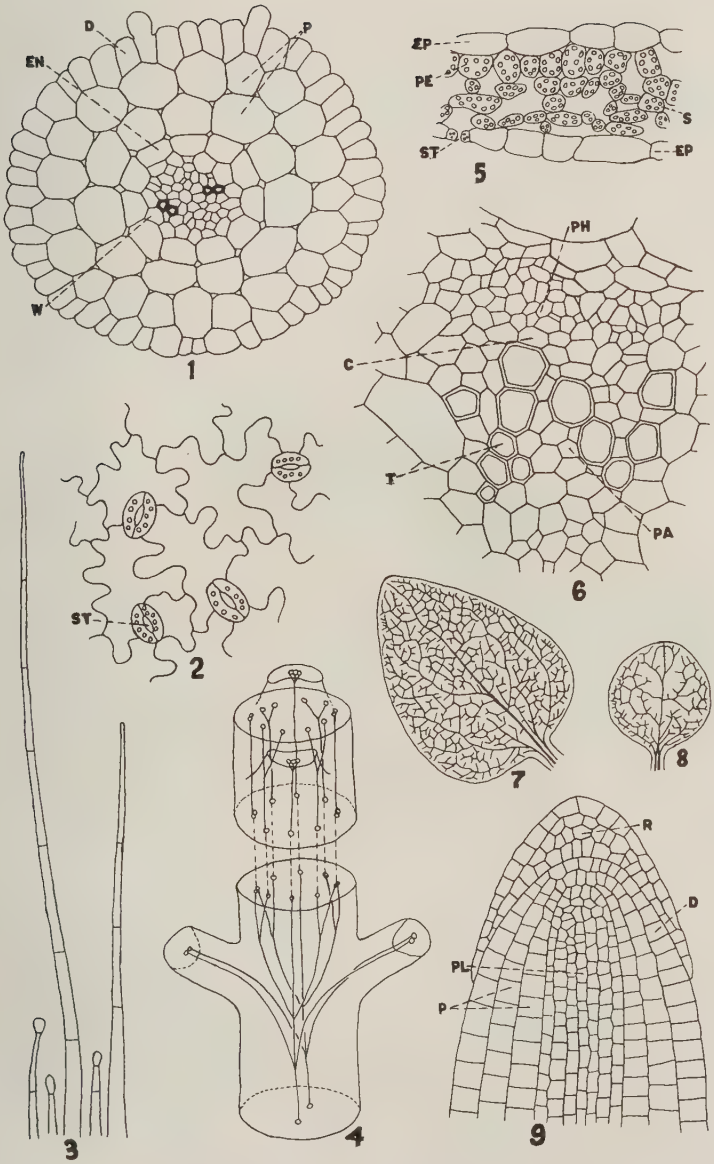
FIG. 5. Cross section of hypocotyl just below cotyledons, showing the two branch bundles which arise from each of the two hypocotyl bundles. × 22

FIG. 6. Cross section of hypocotyl just above region shown in Figure 5. The four branches have passed out into the cotyledons, and the two original bundles have each again sent off two branches. × 16

FIG. 7. Cross section of internode just above the cotyledons. Six bundles are evident in the internode, and two in each cotyledon. × 10

FIG. 8. Cross section of leaf node, showing three bundles passing into the base of each petiole and the formation of the ten bundles in the internode above the first leaves. × 10

FIG. 9. Cross section of internode above the first leaf node. The ten bundles are plainly evident. × 10



Seedling anatomy of *Antirrhinum majus* L.

EXPLANATION OF PLATE II

FIG. 1. Cross section of root tip, showing the epidermis, parenchyma of cortex, endodermis, pericycle, and diarch bundle. × 207

FIG. 2. Surface view of lower epidermis of leaf. × 207

FIG. 3. Hairs on parts of seedling above the ground. × 75

FIG. 4. Diagram showing course of vascular bundles in seedling above the transition zone.

FIG. 5. Cross section of leaf, with loosely arranged mesophyll cells. × 430

FIG. 6. Cross section of one of the vascular bundles in the internode above the first leaf node. × 430

FIG. 7. First leaf, showing shape and venation. × 4

FIG. 8. Cotyledon, showing shape and arrangement of veins. × 4

FIG. 9. Longitudinal section of root tip. Rootcap and primary meristem evident. × 407

Seedling anatomy of *Antirrhinum majus* L.

FORESTRY

SOME RESUPINATE POLYPORES FROM THE REGION OF THE GREAT LAKES. XII

DOW V. BAXTER

FIELD work must necessarily complement studies of authentic types and herbarium specimens. Accordingly, numerous expeditions have been made to various sections of the continent in the effort to secure representative material for this investigation.[1] Many of these plants, reported for the first time in some localities, are from Alaska, the Yukon Territory, and the Northwest Territories. The majority of the American plants have been taken to Europe for comparative study during the course of the work.

This paper reports observations made on seven polypores of North America. Three of the porias are new, *Poria Taxodium*, *P. carnicolor*, and *P. Carnegiea*. *P. Carnegiea* is the first polypore described on *Carnegiea gigantea*, the giant sahuaro.

Poria Taxodium, sp. nov.

(Plate I)

Type:

Poria Taxodium, sp. nov., on *Taxodium distichum*, greenhouse benches, Hillsboro, Illinois. Type. Coll. Dow V. Baxter. Herb. Dow V. Baxter, Ann Arbor.

Planta resupinata, fructificatione annua, tenui, alba, aetate pallide ochracea, late effusa usque ad 30 cm., maturitate planta ex

[1] Throughout the work upon these monographs I am indebted to many individuals and institutions for suggestions, help, and privileges extended to me. My appreciation is expressed particularly to the men who have accompanied me on my several expeditions to Alaska, the Yukon Territory, and the Northwest Territories. Much credit is due them for aiding in the collection and care of the specimens and for living at times under rather difficult circumstances. I am under obligation to Professors T. G. Halle and Gunnar Samuelson of the Naturhistoriska Riksmuséet in Stockholm, with whom I have had the pleasure of association. Thanks are rendered several American institutions and scholars also. To the authorities at the New York Botanical Garden, to Professor H. H. Bartlett, of the University of Michigan, to the staff of the Division of Pathological and Mycological Collections of the United States Department of Agriculture, and to the staff of the Division of Forest Pathology of the same department, I am especially indebted.

flat sheets of white mycelium appear in the wood and have a "soapstone" feeling when handled.

Remarks. — This is one of the most colorful, if not the most colorful, of all the porias.

Poria Carnegiea, sp. nov.

(Plate III)

Type:

Poria Carnegiea on bundles of *Carnegiea gigantea* (Engelm.) Britton and Rose. Coll. Dow V. Baxter, Tucson, Arizona, July 14, 1938. Herb. Dow V. Baxter, Ann Arbor.

Fructificatio annua, primum arachnoidea, tenuis, 1–3 mm. crassa, effusa in areis non longioribus quam 15 cm., plerumque ca. 5–7 cm. longitudine, 1–1.5 cm. latitudine; margine arachnoideo, obscuro, plerumque ca. 3–4 mm. lato, albido; subiculo albido, minus quam 0.3 mm. crasso; tubis primum albidis, aetate siccitateque cinnamomeis vel argillaceis vel brunneis, 0.5–2 mm. longis; aperturis cum tubis concoloribus, angularibus, fimbriatis, 1–5, plerumque 3–4, in uno mm., mox coalescentibus et crescentibus; basidiis plerumque ca. 9–11 × 3–4 μ; sporis 4 × 2–3 μ; hyphis hyalinis, interdum septatis, sparse ramosis, fibulatis.

Fructification annual, arachnoid at first, thin, 1–3 mm. thick, effused in patches mostly not longer than 15 cm. and usually about 5–7 cm. in length and 1–1.5 cm. wide; margin arachnoid, indefinite, mostly 3–4 mm. wide, whitish; subiculum whitish, less than 0.3 mm. thick; tubes whitish at first, drying to "cinnamon-buff," or "clay-color" to "Sayal brown," 0.5–2 mm. long; mouths concolorous with tubes, angular, fringed, 1–5 mostly 3–4 to a mm. but soon coalescing and becoming larger; basidia mostly 9–11 × 3–4 μ; spores 4 × 2–3 μ; hyphae hyaline, occasionally septate, not much branched; clamp connections present; no cystidia.

Allied species. — The white margin of this plant and the thin nature of the fruiting body might suggest *Poria vulgaris*, but the two may be distinguished by the fact that the spores of *P. vulgaris* are 1–1.5 × 4–6 μ, whereas those of *P. Carnegiea* are 4 × 2–3 μ. Furthermore, the tubes of *P. Carnegiea* often coalesce and the mouths become much larger than those of *P. vulgaris*.

Remarks. — This plant is the first poria described on cactus. It grows on the giant sahuaro, but has been overlooked partly be-

cause of the relatively limited distribution of the host and partly because it is not found on the outside of the fallen plant, as is usual with other resupinates. *Poria Carnegiea* grows on the bundles of the cactus, so that the outer part of the plant must be pulled away or torn apart before the fungus is discovered. There is evidently more moisture and a cooler temperature on the interior of the sahuaro, factors which undoubtedly favor the growth of *P. Carnegiea* on the bundles rather than on the outside.

Fuscoporia juniperina Murrill, North Am. Fl., 9, Part 1: 4–5. 1907

(Plate IV, Figures 1–2)

Type and important specimen:

Fuscoporia juniperina on fallen trunks of *Juniperus virginiana*, Dec. 3, 1888. A. B. Langlois 1584. Herb. New York Botanical Garden, New York.

Fuscoporia juniperina on *Taxodium distichum*, Arkansas. Coll. Dow V. Baxter, 1933. Herb. Dow V. Baxter, Ann Arbor.

Fructification effused for 14 cm. or more, inseparable, coriaceous to woody, mostly 1.5–4 mm. thick; margin sterile, mostly less than 1 mm. wide, "snuff-brown"; subiculum up to 0.5 mm. thick, concolorous with tubes; tubes in one or two layers, "snuff-brown" to "bister," up to 5 mm. long but mostly 1 mm. or less; mouths mostly 6–7 to a mm., "Dresden brown," "snuff-brown," "bister" or "Natal brown"; dissepiments thick, entire; spores globose, smooth, hyaline, 5–6 μ (Murrill); cystidia rare (Murrill); no setae.

This plant when young resembles *Poria ferruginosa* and might well be mistaken for it in one-year growth forms. The type specimen and also other and older specimens appear more woody than *P. ferruginosa* ever does, and in the woody condition the species suggests a young form of *Fomes igniarius laevigatus* in color and texture. The reddish brown ("Natal brown") of old plants and of bruised parts even of many young forms is characteristic for the species. Although the tubes often occur in layers, the plant is relatively thin compared to *F. igniarius laevigatus.*

Habitat. — *Juniperus virginiana, Taxodium distichum.*

Distribution. — Arkansas, Louisiana.

Decay. — *Fuscoporia juniperina* causes a white laminated sap rot in

Taxodium (Pl. IV, Fig. 2). Fine brown lines appear throughout the decayed wood, which separates in thin paper-like sheets.

Daedalea juniperina Murrill, North Am. Fl., 9, Part 2 : 125. 1908

(Plate V)

Agaricus juniperinus Murr., Bull. Torr. Bot. Club, 32 : 85. 1905.

Fructification corky, sessile, attached by a broad, frequently decurrent base, pileate specimens imbricate, pilei 2–5 × 2–10 × 1.5–3 cm.; surface finely tomentose to nearly glabrous, "pinkish buff" to "cinnamon-buff" or "cinnamon-brown," becoming blackish at base or in older specimens; margin becoming fertile, mostly "pinkish buff"; context corky, "pinkish buff," concentrically banded, 0.3–1 cm. thick; furrows labyrinthiform, 0.5–2 cm. long, 1–3 mm. wide, mostly "cinnamon-buff," edges often becoming irpiciform; spores cylindric, smooth, hyaline, 2–3 × 5–7 μ; hyphae hyaline, 3–7 μ; no cystidia.

Allied species. — Resupinate specimens may suggest *Trametes Peckii* Kalch., but the spores of *T. Peckii* are much longer and measure 12–15 × 4 μ. *T. Peckii* is most common on willows and poplars, whereas *Daedalea juniperina* occurs most often on juniper. Some specimens bear a resemblance to *D. quercina*, but the context is lighter in color in *D. juniperina* and the plants do not become so large as those of the hardwood-inhabiting plant.

Irpex Galzini Bres. grows on juniper also and this plant may be even more difficult to separate from *Daedalea juniperina*, although there are no records of it from America. *I. Galzini* is somewhat more fragile than the Daedalea and its spores are "4.5–5.5 × 1–1.5 μ" (B. & G.) (Pl. VI).

Well-developed specimens which have dark pilei may resemble young *Fomes juniperinus*, for even when young the upper surface of *F. juniperinus* is brown, with numerous cracks, and becomes almost black and very rough, as does the surface of *Daedalea juniperina*.

Habitat. — *Juniperus utahensis, J. virginiana.*

Distribution. — Arizona, Kansas, Kentucky, Missouri, Oklahoma.

Polystictus cuneatus, comb. nov.

Coriolellus cuneatus Murr., North Am. Fl., 9 : 28. 1907.

Type and important specimen:

Coriolellus cuneatus Murr. on bark of "giant cedar," British Columbia, Aug., 1887. Coll. John Macoun 60. Herb. New York Botanical Garden, New York.

Polystictus cuneatus on *Thuja plicata*, Vancouver, British Columbia, Aug. 22, 1932. Coll. Dow V. Baxter. Herb. Dow V. Baxter, Ann Arbor.

Fructification on bark of logs, posts, and dead standing trees, thin, flexible, cuneate to dimidiate, imbricate, or often resupinate-reflexed or resupinate, sometimes extending two or more meters over the substratum; surface villose to strigose, azonate, mostly 1–2 mm. thick; tubes white to "cream-buff," 1 mm. or less in length; mouths 1–3 mostly 2 to a mm.; dissepiments thin, dentate-lacerate, becoming irpiciform; spores smooth, globose, hyaline, 3–4 μ.

Allied species. — This plant is readily distinguished from other species in the Polystictus group. The flexible or pliable nature of the fruiting bodies when old may suggest weathered *Polystictus abietinus* but the color of even the old pores as well as the surface of the pileus of *Pol. cuneatus* remains whitish or cream. The pores and the surface of the pileus are often concolorous in *Pol. cuneatus*, but in *Pol. abietinus* the pores in age may change from a pink or violet shade to brownish, and generally they are not concolorous with the surface of the pileus.

Habitat. — *Thuja plicata.*

Distribution. — British Columbia, Washington.

Occurrence. — This plant grows abundantly in southwestern British Columbia. It is common particularly on rustic timbers of the western red cedar, where the bark has not been removed, and likewise abundant on small dead trees in the forest. The fungus is often overgrown with moss.

Fomes annosus (Fr.) Cooke, Grevillea, 14 : 20. 1885

(Plate VII)

Polyporus annosus Fr., Syst. Myc., 1 : 373. 1821.

Polyporus serpentarius Pers., Myc. Eur., 2 : 82. 1825.

Polyporus subpileatus Weinm., Syll. Pl. Nov., 2 : 102. 1827.

Polyporus resinosus Rostk. in Sturm, Deutsch. Fl., 4 : 61. 1830. Non (Schrad.) Fr. 1821.

Trametes radiciperda R. Hartig, Wicht. Krankh. Waldb., p. 62. 1874.

Fomitopsis annosa (Fr.) Karst., Rev. Myc., 3: 18. 1881.
Polyporus Gillotii Roum., Gillot, Rev. Myc., 4: 234, Pl. 32. 1882.
Heterobasidion annosum (Fr.) Bref., Unters. Gesammt. Myk., 8: 154. 1889.
Polyporus irregularis Underw., Bull. Torr. Bot. Club, 24: 85. 1897.
Ungulina annosa (Fr.) Pat., Ess. Tax. Hymen., p. 103. 1900.

Fructification perennial, effused-reflexed, appearing above ground at base of coniferous trees or often resupinate on underneath side of roots of upturned or tipped trees or on exposed roots, mostly applanate, coriaceous or woody, very irregularly lobed; pileus 4.5–14.5 × 3.5–17 × 0.5–3.5 cm.; surface velvety to nearly glabrous, rugose, zonate, more or less encrusted, new growth "pinkish buff," "Verona brown" to "warm sepia," becoming "chestnut-brown" to blackish; margin entire to wavy, at first white and becoming brown; context "light buff," corky, 1 cm. thick or less, upper part forming a dark horny pellicle; tubes "light buff" to "pale ochraceous buff," frequently in a single layer indistinctly and unevenly stratified, layers loosely held together and often separating, many old tubes stuffed, 2–20 mostly 2–7 mm. long each season; mouths whitish, 2–3 to a mm.; basidia 30–40 × 8–10 μ (Hiley), 2- to 4-spored; spores hyaline, smooth, ovoid, 4–6 × 3–4 μ (Shope); hyphae of context (pellicle) seldom branched, 1–3 μ in diameter; no cystidia; conidia seldom occurring in nature but appearing on fructifications kept in damp chambers, capable of producing new mycelia while still on conidiophore; conidiophores usually developing in cultures and often appearing in large bundles approximately 5 mm. in length, sometimes swelling at apex and cutting off numerous conidia or under favorable conditions branching and forming coremia (2).

Allied species. — Because *Fomes annosus* is commonly resupinate, it is often labeled Poria by collectors and is sent to me for determination of the species under that genus. It is also not unusual for it to be called Trametes. Actually, the fungus became well known to European foresters as *Trametes radiciperda* because of the classical studies of Robert Hartig (5). There are no porias which are closely related to *F. annosus*. *T. serialis* differs in its habit of growth and can be distinguished by the fact that its margin is not at all wavy or lobed. *Microscopically*, *F. annosus* differs from *T. serialis* in many of its features. The spores of *F. annosus* are ovoid, 4–6 × 3–4 μ, whereas those of *T. serialis* are cylindric-ellipsoid, 7–9 × 2–3 μ.

Fomes annosus is more likely to be confused with *F. applanatus* (on conifers) and *F. pinicola* when these two fungi occur in the resupinate state than it is with *Trametes serialis*. As a matter of fact, *F. applanatus* and *F. pinicola* are sometimes difficult to separate when these forms occur in the very wet coastal forests of British Columbia and Alaska, even when a pileus is present. The context in *F. applanatus* is brown (dark brown in typical specimens), but it is whitish or yellowish white in *F. annosus*. The mouths of *F. pinicola* darken when bruised more conspicuously than do those of *F. annosus*. The fact that the upper part of the context in *F. annosus* forms a dark thin pellicle should aid in distinguishing it. The spores of *F. applanatus* are brown; those of both *F. annosus* and *F. pinicola* are hyaline.

Because the tubes of *Fomes annosus* are often in one layer and because its context is corky and its spores subglobose, the plant has been confused with the white forms of *Pol. unitus* (*Poria medulla-panis*). The much-branched mycelium in *Pol. unitus* and its more or less regular (not wavy) marginal characteristic should enable one to distinguish the two species.

Habitat. — *Abies amabilis, A. concolor, A. grandis, A. lasiocarpa, A. magnifica shastensis, Acer macrophyllum, Castanea dentata, Chamaecyparis thyoides, Diospyros virginiana, Juniperus virginiana, Larix occidentalis, Picea Engelmannii, P. rubra, P. sitchensis, Pinus caribaea, P. contorta, P. echinata, P. glabra, P. monticola, P. muricata, P. palustris, P. ponderosa, P. resinosa, P. rigida, P. Strobus, P. taeda, P. virginiana, Populus balsamifera, P. trichocarpa, Pseudotsuga taxifolia, Quercus prinus, Q. utahensis, Sequoia sempervirens, S. washingtoniana, Thuja occidentalis, T. plicata, Tsuga canadensis, T. heterophylla.*

Distribution. — British Columbia, Alabama, Alaska, Arizona, Arkansas, California, Colorado, Connecticut, District of Columbia, Florida, Idaho, Indiana, Iowa, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, New Jersey, New Mexico, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, South Dakota, Virginia, West Virginia, Washington, Wisconsin.

Occurrence. — *Fomes annosus* is distributed throughout the North Temperate Zone and is especially prevalent in Europe. In North America it is common as a saprophyte and is known to cause butt

rot, especially in living juniper, red spruce, white pine, and pitch pine in the East. It is often reported in the Douglas fir–hemlock forests of the Pacific Northwest and I have made abundant collections of it on western hemlock in the Tongass National Forest in southeastern Alaska. *F. annosus* is not a serious pest there.

Both European and American investigators have suggested that possibly various strains of the fungus exist and that the form or forms of *Fomes annosus* most prevalent in the United States at least differ with reference to their parasitism from the form or races abroad. The fact that practically all the American conifers introduced into Europe have been attacked and actually damaged by the fungus in plantations there gives rise to the belief that physiologically the American fungus differs from the European species (11).

Fomes annosus occurs rarely on structural timbers except in mines, although I have found it fruiting on a Scotch pine fence post in Sweden. The fungus, however, is usually observed on roots, stumps, or at the base of standing or tipped trees or snags in the forest. It is, of course, to be seen on the roots of recently wind-felled trees. *Trametes serialis*, on the other hand, is most common on logs of trees which have been down for longer periods and on lumber, occurring abundantly on basal logs in cabins throughout much of northern North America and on heavy structural timber.

Decay. — Coniferous wood infected with *Fomes annosus* becomes pink or lilac in the incipient stages of decay and then turns yellow or brown. When the wood becomes visibly decomposed numerous pockets lined with white fibers or white mycelium occur, and a black spot appears in the pockets, which coalesce so as to form large masses of white spongy fibers. On the ends of logs the rot appears in rings because of the more rapid destruction of the springwood. Roots are attacked first.

In trees with low resin content the decay frequently extends several feet up the trunk, but in those conifers with high resin content the rot is usually confined to the butt (7).

Importance of decay and methods of handling infested stands. — In European countries this root-decaying fungus (together with *Armillaria mellea*) is considered among the most serious causes of failure in forest plantations. Likewise, it does much damage in

the natural forests. In Germany, for example, Falck (3) reports that the loss in value of fir varies from 8 to 21 per cent as a result of this fungus. "There is much to indicate that it is much more noxious in Denmark," according to Lind (8), "than in neighboring countries, — half of all Danish firs are destroyed by it."

Infection varies somewhat with the age and species of trees. Douglas fir, Lawson's cypress, and white pine are prevalently attacked when young, according to Hiley (6), whereas larch, spruce, and Scotch pine exhibit rot most generally when old. Although in Europe I have seen *Fomes annosus* on trees of less than ten years' growth, the fungus seems to be commonest in older ones. I have observed spruce trees in Sweden and elsewhere in Europe in which only the heartwood had been attacked. In young and old trees decay in the sapwood, the heartwood, or in both is common. Old trees are usually not killed unless suppressed, but since they are weakened by rot much of their value is lost in windfall.

The group system or a combination of the group and the strip systems is practiced in many forests abroad in the effort to avoid clear-cutting and to create an all-aged forest in the future. The infected timber is salvaged if possible. Mixed stands, particularly if beech or other hardwoods are the associated species, are less likely to be damaged seriously than are pure forests.

In America it has not been so generally necessary to inaugurate special silvicultural practices in the forest because *Fomes annosus* seldom causes much damage here. In the eastern United States, however, there are many reports of it both in plantations and in the natural forest. The fungus is prevalent, for example, in the historic forest plantations at Biltmore, North Carolina (4), and it is likely to become a serious pest in other plantations as they grow older. In certain California forests, too, Meinecke (9) predicts that it will become more abundant. These beliefs are based in part at least on the present treatment of the natural stands during logging operations, their frequent subjection to fire, and the deterioration of the forest sites as a result of such abuse, as well as on the expectation of a larger proportion of older plantations than we now have.

Anderson (1), who made extensive investigations in Scotland, reports that the fungus was "originally a purely saprophytic

type" and was confined to dead material, such as old roots, stumps, and fallen branches. Conifers were in demand there and were planted on sites unfavorable for their growth. Since the fungus is capable of attacking trees under such circumstances, and since the area is already so contaminated, conditions seem more conducive to its spread.

Fomes annosus is the indirect cause of some windfall in both eastern and western American forests. Although it has been observed on fence posts and dead timber, it does not play an important part in the destruction of slash over wide areas. It often rots coniferous props in mines, however, and is in some localities a prevalent cause of decay in such timbers.

Poria vaporaria Fr., Hymen. Eur., p. 379

Poria sinuosa-vaporaria Fr. *sensu* Romell. Svensk Botanisk Tidskrift, 20: 21. 1926.

Polyporus sinuosus Fr. *sensu* Romell, Bresadola. Svensk Botanisk Tidskrift, 20: 17. 1926.

Poria silvestris in Swedish literature.

Type, cotypes, and important specimens:

Poria sinuosa Fr. typica! 35. Eichler. Herb. of Bresadola, Stockholm.

Polyporus vaporarius Fr., f. *regularis*, ex Karsten. Herb. of Bresadola, Stockholm.

Polyporus vaporarius Nattavara, 1910. Hymen. Lapp. Herb. Mycolog. Lars Romell, Stockholm.

Poria sinuosa, ex Herb., J. R. Weir 10784. Herb. Mycolog. Lars Romell, Stockholm.

Poria Friesii Romell. Leg. Seth Lundell. Herb. Mycolog. Lars Romell, Stockholm.

Fructification annual, somewhat coriaceous even when fresh, effused in elongated patches usually up to 35 cm. or more, about 1–2 mm. mostly 1.0 mm. thick, separable from the substratum in small pieces when fresh; margin appressed, fimbriate, up to 1 mm. wide, whitish, "pinkish buff," becoming fertile; subiculum less than 0.5 mm. thick, "pinkish buff"; tubes 0.5–2 mm. long; mouths 1–3 mostly 1–2 to a mm., whitish "ivory-yellow" to "pinkish buff" when fresh, drying to "clay-color" and sometimes "Sayal brown"; dissepiments mostly 130–310 μ thick, somewhat dentate; basidia 4-spored, 18–21 $\times$ 4.5–7 μ; spores nonguttulate, cylindrical or allantoid, 4–6 (4–5.5 $\times$ 1) 1–2 μ; hyphae 1.5–2.5–3 μ in diameter, seldom septate, much branched; clamp connections present.

Allied species. — Many white or whitish plants have been placed under the name *Poria vaporaria*. *Polyporus versiporus* was, for example, referred to both *P. vulgaris* and *Pol. vaporarius* by Fries. Romell (10) believed that *P. sinuosa* and *P. vaporaria* as interpreted at first by himself and Bresadola were, in all probability, identical plants.

The species of Fries, according to Romell and other European authorities, is entirely different from *Poria vaporaria* in the sense of Hartig, Hennings, Rostrup, and Metz. The plant of Fries grows "*in pineto-montanis*," with spores 4.5–6 × 1.5–2 μ, whereas the other poria, which grows commonly in cellars, hothouses, and so on, has elliptical spores 5–7 × 3–3.5 μ. I have collected the Swedish plant around Stockholm and Uppsala and elsewhere in the Scandinavian countries, usually on coniferous pine logs in the forest. Here the fungus occurs more frequently than it does in America. It is especially common in timberlands similar to the lodgepole pine forests of the American West.

At least two distinct plants are known as *Poria vaporaria*, and many others have been so labeled in herbaria. It is true that Romell suggested the new name *Polyporus Friesii* for the Friesian species in order to separate it from the species of Persoon (the plant found in cellars). Bresadola, however, used the name *P. Vaillantii* for the fungus which appears to be that of Persoon. Bourdot and Galzin have retained the name *P. vaporaria* for the Swedish plant of the woods with spores "4–6 × 1–2" μ and usage has seemed to establish this name for that species. Though somewhat contrary to rules, it seems therefore both the sensible and by far the most practical procedure to refer the name *P. Vaillantii* to the white plant of Persoon (a cellar plant with spores 5–7 × 3–3.5 μ and usually rhizomorphic) and retain the name *P. vaporaria* for the fungus which occurs so commonly in the Swedish forests, not ropy and with spores 4.5–6.5 × 1.5–2 μ.

Young specimens of *Poria vaporaria* (as recorded near Uppsala, in the field) might at first be mistaken for the more whitish forms of *P. xantha*, but a critical examination will readily reveal the differences in pore sizes. Even in young specimens, the pore mouths of *P. vaporaria* are larger and often appear daedaloid under the hand lens.

Old specimens of *Poria vaporaria* may suggest *Trametes serialis*,

but can be separated by their different spore characters. *T. serpens*, also, has been called *P. vaporaria* but may likewise be distinguished on the basis of spore characteristics.

Habitat. — *Abies balsamea, Larix occidentalis, Picea Engelmannii, P. glauca, P. mariana, P. sitchensis, Pinus banksiana, P. caribaea, P. contorta, P. lambertiana, P. monticola, P. ponderosa, P. Strobus, P. radiata, P. rigida, Pseudotsuga taxifolia, Thuja occidentalis, Tsuga heterophylla, T. mertensiana.*

Distribution. — Alberta, Northwest Territories, Ontario, Quebec, Yukon Territory, Alabama, Alaska, California, Georgia, Idaho, Michigan, Minnesota, Montana, Nebraska, New Hampshire, New Jersey, New York, Oregon, Pennsylvania, Washington.

Decay. — The fungus produces a dry cubical brown rot in coniferous logs in the woods. It occurs chiefly on the larger slash in the forest.

The literature is confusing in respect to the damage caused by this fungus, since the species called here *Poria Vaillantii* has been designated often in reports by various authors as *P. vaporaria*. *P. Vaillantii* is found in basement timbers and causes a rot similar to that of *Merulius lacrymans*.

The Swedish plant named in the present studies *Poria vaporaria* is not the same *P. vaporaria* designated by Gäuman in the well-known studies on the rate of decay in timber felled at different seasons of the year. The spores of his plants measure "4–6 × 3–5" μ or "5–7 × 4–6" μ. This interpretation of *P. vaporaria* is perfectly understandable in view of the confusion that exists in the literature regarding the species. Gäuman's *P. vaporaria* is actually *P. versipora* (Pers.) Romell.

University of Michigan

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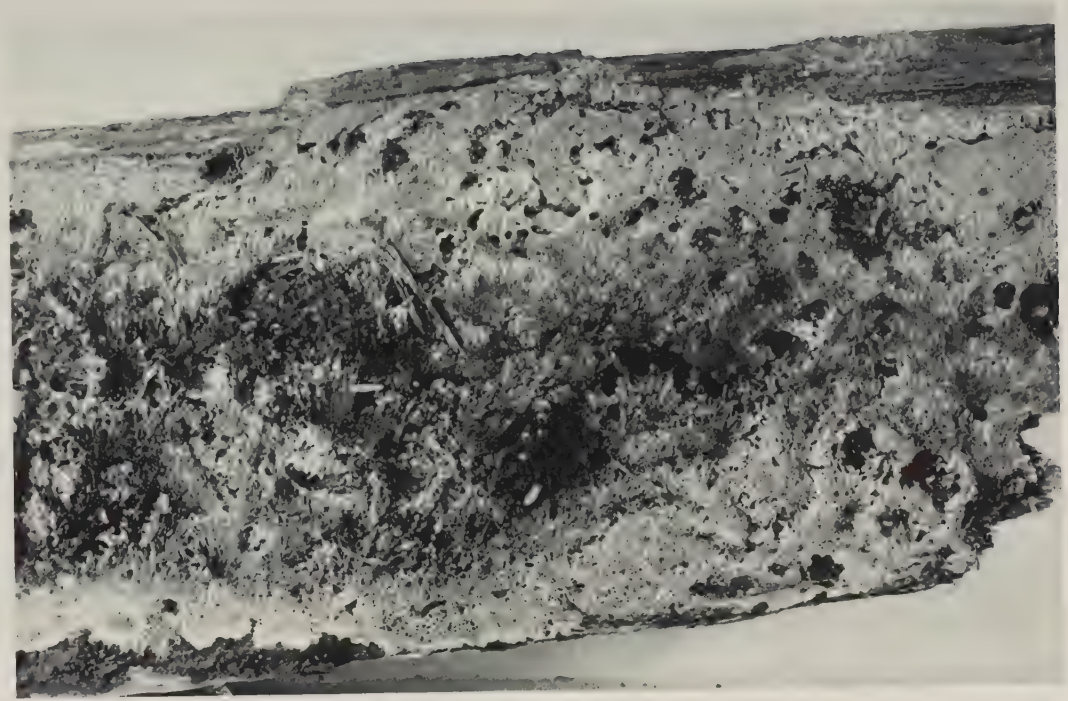
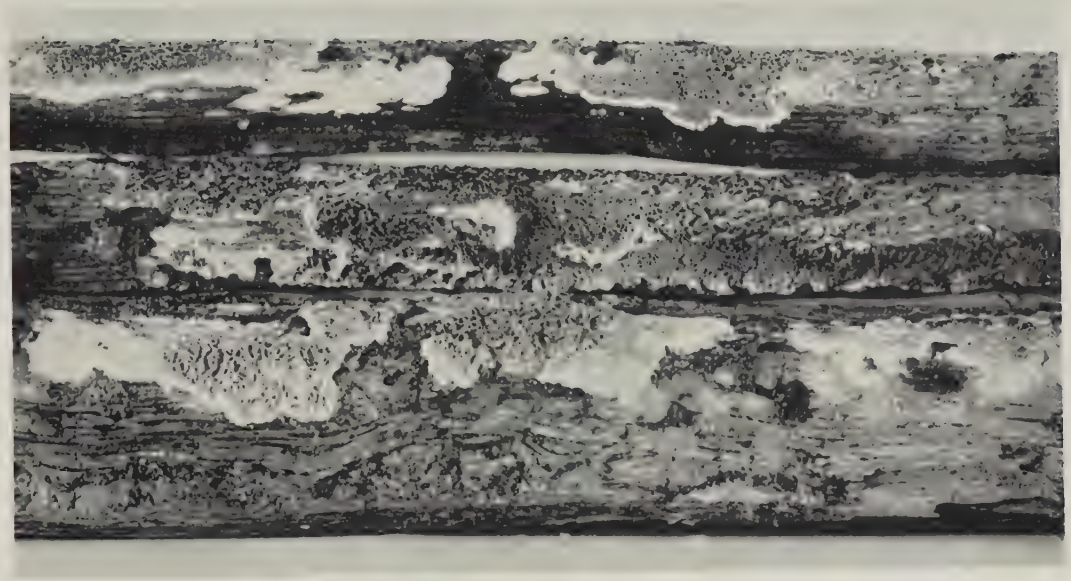
PLATES I–VII

Poria Taxodium, sp. nov., on *Taxodium distichum*, Hillsboro, Illinois



Poria carnicolor, sp. nov., on *Tsuga heterophylla*, Priest River, Idaho



Poria Carnegiea, sp. nov., on *Carnegiea gigantea*, Tucson, Arizona

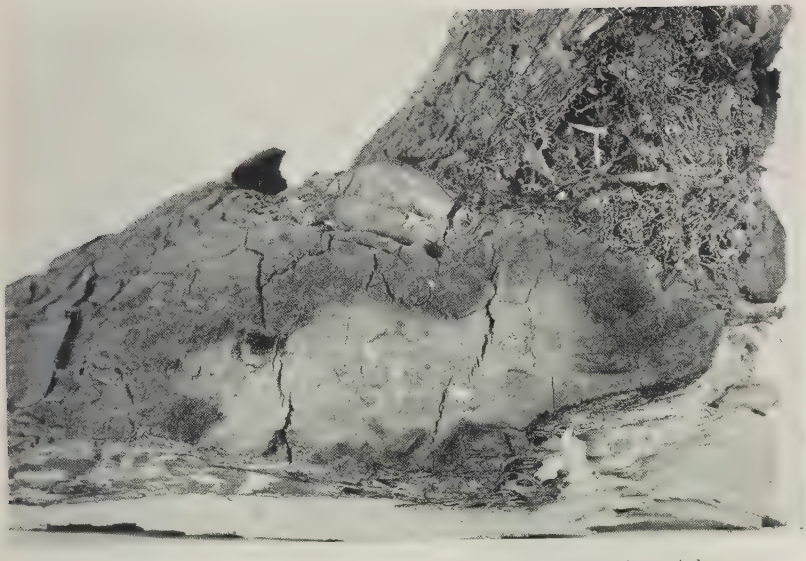


FIG. 1. *Fuscoporia juniperina* Murr. on *Taxodium distichum* from Arkansas

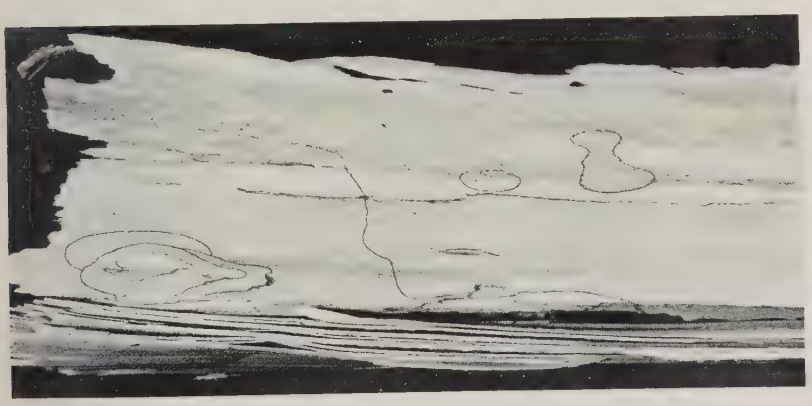
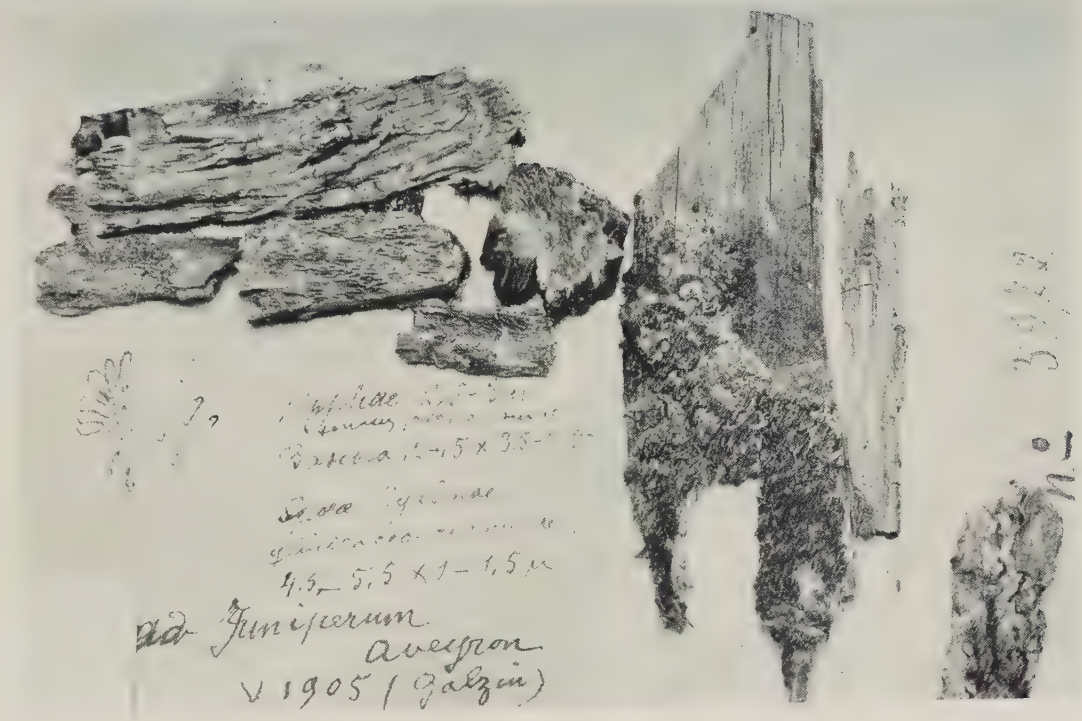


FIG. 2. Sap rot of *Taxodium distichum* caused by *Fuscoporia juniperina* Murr.

Daedalea juniperina Murr. on *Juniperus utahensis*,
Sedona, Arizona. Coll. W. H. Long



Irpex Galzini Bres. Coll. Galzini, Bresdola herbarium, Stockholm, Sweden

Fomes annosus (semiresupinate form) on *Tsuga heterophylla*, Sitka, Alaska

GROWTH ON CUTOVER SPRUCE–FIR PULPWOOD LANDS IN NORTHERN MICHIGAN

ARTHUR B. BOWMAN

INTRODUCTION

SPRUCE and fir stands in northern Michigan probably offer greater opportunity for the practice of forest management than any of the other forest types in this region, because of the relatively short rotations and cutting cycles upon which they can be operated. Owing to their comparatively low fire hazard they are also safer investments. Despite these advantages forest management has not progressed, or even gotten a fair start, since we know so little about the growth and yields of the major pulping species, of the probabilities of renewing them after cutting, of the factors accounting for windfall, mortality, and losses from logging, of proper slash-disposal methods, and a host of other problems. A comprehensive study designed to furnish an answer to some of these questions has been under way at Michigan State College for several years. It is hoped that by the end of the coming field season (1940) sufficient data will have been gathered to enable us to complete the analysis of the whole project and to issue a bulletin on it. Thus far results are available only on cutover areas.

ANALYSIS OF GROWTH

Through the efforts of several field crews data on about 90 cutover plots have been gathered. They relate to material removed at the time of cutting, material left after logging, growth of sample trees, quantity and condition of the reproduction, and various other factors such as vegetative cover, timber type, density, soil type, drainage, date of logging, and history of the area. A preliminary investigation disclosed that some of the plots were abnormal and had to be eliminated; in the end only 83 plots remained for further analysis. These plots represented, however, just about every conceivable condition, from very light to very heavy removals and from recent to relatively

old cuttings. Some represented areas that had been cut over more than once. Diverse as the conditions were, it was felt that the growth trends would be more strongly defined by creating additional new plots from the original ones. Consequently, each plot that had been cut over 15 or more years served to produce at least one new plot by reconstruction of the stand at 10-year intervals after cutting. As an example, data from an area cut over 28 years ago served to

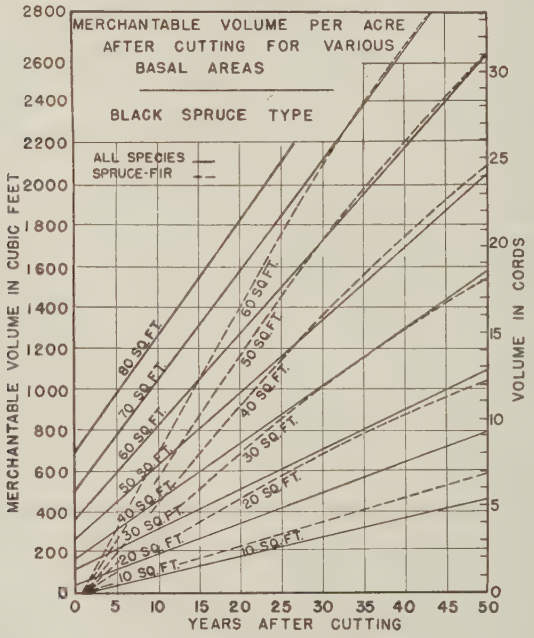


Fig. 1

produce data for 10 and 20 years after cutting. Increment borings and a record of mortality losses facilitated this determination. This method of acquiring "new plots" is perfectly sound and legitimate, and is followed in most growth studies of this nature. Furthermore, it is believed to be fairly reliable in view of the many borings taken — some 1,800. Altogether, 88 new plots were created, which, with the original ones included, were divided among three different forest types as follows:

Black spruce	68
White spruce–balsam fir–paper birch	68
Northern white cedar	35
Total	171

It was obvious at the outset that the three most important factors affecting stand volume after cutting were site quality, quantity of growing stock that was left, and the elapsed time. It was also obvious

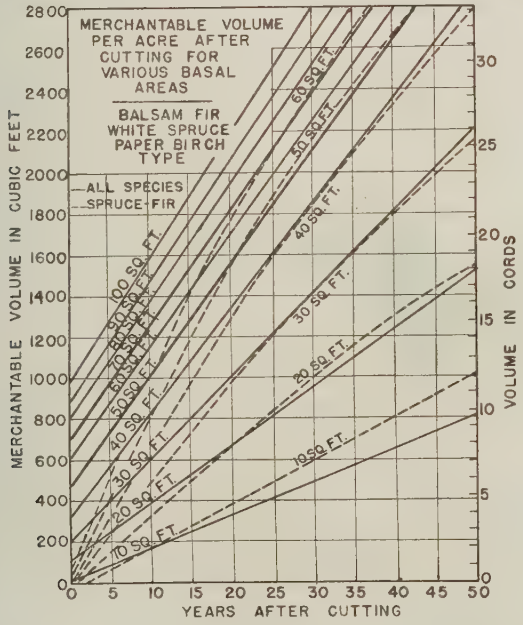


Fig. 2

that the plots should be separated on this basis if the influence of each factor was to be ascertained. Instead of separating the plots into site qualities, however, which would have presented unusual difficulties at the time, they were simply segregated by former forest types; close correlation between type and site was implied. With the plots classified in this manner it was necessary only to select some graphic method of averaging plot volumes by the use of two factors, residual basal area and number of years after cutting, as independent vari-

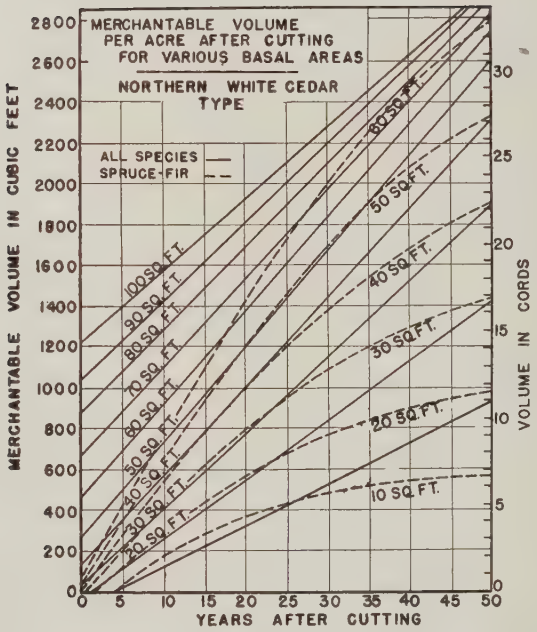


Fig. 3

ables. Residual basal area was employed as an independent variable instead of residual merchantable volume because it appeared to be more closely related to the annual growth. For example, many plots which had been cut over heavily had no merchantable volume, yet they grew at totally different rates because of and in proportion to the basal area that remained.

Re-creation of the residual stand and its original basal area was accomplished in much the same manner that the stand had been reconstructed at 10-year intervals after cutting, viz., by subtraction of diameter growth and addition of mortality losses. These values, when finally secured, proved to be very irregular and had to be brought to even intervals of 10 square feet by interpolation.

A graphic method [1] relating the dependent variable to two inde-

[1] Bruce, Donald, and Schumacker, F. X., *Forest Mensuration.* New York: McGraw-Hill Book Co., 1935.

pendent variables, neither of which is related to the other, was then chosen. It involved the preparation of a curve for the dependent variable (volume) over one of the independent variables (years after cutting) and then investigating the relation between the residuals from this curve and the other independent variable (residual basal area). In the end two sets of curves were drawn on each graph, one for spruce and balsam fir and the other for all species. Figures 1, 2, and 3 (pp. 124–126) show these graphic relationships, and Table I (pp. 128–129) gives the values taken from them.

DISCUSSION

Wide variation in the origin of each set of curves seems odd, but in view of the cutting practices employed in this region is not altogether surprising. These practices allow little or no merchantable volume of spruce and fir to remain after cutting, but frequently permit large amounts of the other species to do so. The pitch of the curves shows the rapidity of growth of each group. It is significant that the volume of spruce and fir exceeds that of all species combined by about 1.4 times in all types except the white spruce–balsam fir–paper birch; here it is about even. It is even only because considerable quantities of aspen make up for the slow growing tendencies of the other nonpulping species.

This comparison of growth rates might be misconstrued. It does not mean that the spruce and fir in a certain stand would grow 1.4 times as fast as all the trees in the stand, but simply that a stand of spruce and fir would grow faster than one of mixed species, including spruce and fir, if equal amounts of basal area were present.

Conformity of the curves to the original data may be judged by the size of the aggregate difference. Should the difference work out to within one per cent, as it does in each of these cases, the curves are said to fit the data acceptably.

Wide variation in volume between the three types indicates that there is considerable variation in site quality. On this account it is probable, but by no means certain, that there is little variation of site quality within each type. The inference might be checked by studying the variation of each plot from the curved average representing that condition. Ordinarily the more a plot is pulled away from the average the more it is affected by site factors and the larger will be the average deviation and variation of site quality within each type.

TABLE I

GROWTH IN MERCHANTABLE VOLUME ON CUTOVER SPRUCE–FIR PULPWOOD LANDS IN NORTHERN MICHIGAN

BLACK SPRUCE TYPE

Residual basal area† in sq. ft.	Number of years after cutting									
	10		20		30		40		50	
	Volume in cords *									
	Spr.–fir	All species	Spr.–fir	All species	Spr.–fir	All species	Spr.–fir	All species	Spr.–fir	All species
10	1.2	1.0	2.6	2.2	4.1	3.2	5.4	4.3	6.8	5.5
20	2.6	2.2	5.4	4.0	8.0	5.8	10.2	7.6	12.1	9.4
30	3.9	3.6	8.1	6.1	12.1	8.6	15.1	11.2	18.3	13.6
40	5.2	5.3	10.9	8.6	16.0	12.0	20.6	15.3	24.5	18.5
50	6.6	7.3	13.7	11.5	20.2	15.7	25.9	19.9	30.8	24.1
60	8.0	9.6	16.5	15.0	24.7	20.3	31.3	25.6	37.0	30.9
70	..	12.2	..	18.6	..	24.9	..	..	..	..
80	..	14.8	..	21.7	..	28.3	..	..	..	..

Aggregate difference, + .002 % (spruce–fir curves) + .70 % (all species)
Average deviation, 48 % (spruce–fir curves) 46.2 % (all species)
Basic number of plots, 68

WHITE SPRUCE–BALSAM FIR–PAPER BIRCH TYPE

Residual basal area† in sq. ft.	Number of years after cutting									
	10		20		30		40		50	
	Volume in cords *									
	Spr.–fir	All species	Spr.–fir	All species	Spr.–fir	All species	Spr.–fir	All species	Spr.–fir	All species
10	2.1	2.1	4.6	4.1	7.2	6.0	9.6	8.0	11.8	10.0
20	3.9	4.6	8.1	8.0	11.9	11.4	15.3	14.8	18.4	18.2
30	5.8	7.1	11.4	12.0	16.6	16.8	21.2	21.5	25.4	26.3
40	7.6	9.6	15.0	15.8	21.5	21.9	27.3	28.0	32.7	34.1
50	9.5	12.0	18.1	18.5	25.2	24.9	31.0	31.4	36.5	37.7
60	11.4	13.6	20.6	20.2	28.3	26.7	34.1	33.2	..	39.7
70	..	15.0	..	21.6	..	28.4	..	35.0	..	..
80	..	16.2	..	23.1	..	30.0	..	37.0	..	..
90	..	17.5	..	24.6	..	31.6	..	..	..	..
100	..	18.8	..	26.6	..	33.0	..	..	..	..

Aggregate difference, + .23 % (spruce–fir curves) + .14 % (all species)
Average deviation, 33 % (spruce–fir curves) 25 % (all species)
Basic number of plots, 68

* 85 cubic feet to one standard cord.

† For equivalent basal areas spruce and fir alone will generally produce more volume at a definite date after logging than will all species combined.

TABLE I (*Concluded*)

NORTHERN WHITE CEDAR TYPE

Residual basal area † in sq. ft.	Number of years after cutting									
	10		20		30		40		50	
	Volume in cords *									
	Spr.–fir	All species	Spr.–fir	All species	Spr.–fir	All species	Spr.–fir	All species	Spr.–fir	All species
10	2.0	1.4	4.4	3.8	5.6	6.1	6.0	8.5	6.7	11.0
20	3.4	2.8	6.8	6.5	9.2	9.9	9.9	13.4	11.5	16.7
30	4.9	4.8	9.3	9.2	12.8	13.6	14.1	18.0	16.9	22.4
40	6.3	6.8	12.0	12.0	16.3	17.0	18.2	22.1	22.4	26.2
50	7.8	8.8	14.3	14.2	20.0	19.7	22.2	25.3	27.4	30.4
60	9.1	10.8	16.8	16.2	23.6	21.6	29.0	27.0	34.0	32.5
70	..	12.9	..	18.0	..	23.1	..	28.2	..	33.4
80	..	15.0	..	19.8	..	24.6	..	29.4	..	34.1
90	..	16.7	..	21.3	..	25.7	..	30.2	..	..
100	..	18.5	..	22.5	..	26.8	..	..	..	..

Aggregate difference, + .95 % (spruce–fir curves) — 1.09 % (all species)
Average deviation, 18 % (spruce–fir curves) 19.3 % (all species)
Basic number of plots, 37

* 85 cubic feet to one standard cord.

† For equivalent basal areas spruce and fir alone will generally produce more volume at a definite date after logging than will all species combined.

Unfortunately, all the average deviations are large, particularly for the black spruce type, and hence it would appear that there are great variations of site quality within each type and a need for breaking the plots up into several groups, so that averages can be obtained for each. It is the opinion of the writer that the wide deviation of plot volumes is due not so much to wide variation in site qualities within each type as to differences in stand structure. Differences in stand structure will cause a stand of, let us say, 20 or 30 square feet of basal area per acre to have no merchantable volume or a rather large amount, depending on the size of the individual trees. Under these circumstances there would be large deviations from the average, even though the site remained the same.

The black spruce type is usually found on very acid wet organic soils. Under these conditions growth in volume is very slow, averaging only about 0.20 cord per acre a year. Whatever growth does occur, however, is generally valuable for pulpwood, because of the heavy representation of black spruce. The white spruce-balsam

fir–paper birch type commonly occurs on better-drained although, perhaps, heavy soils. Here volume growth is almost three times as fast as on the average black spruce site and amounts to 0.55 cord; of this, probably not more than 50 per cent is spruce and fir. The northern white cedar type, with which some of the pulping species are found, occurs principally on the sweeter swampy soils typical of limestone regions. Since it occupies middle ground with respect to moisture and acidity its growth rate, 0.45 cord, is not out of line.

APPLICATION OF GROWTH TABLE

The most important use of the table is in predicting future volumes and volume growth on cutover areas. For this a field survey is essential in which all living trees down to and including the one-inch class should be tallied on a representative portion of the area and the total basal area computed. The type and area of the tract are also needed. If volumetric information for spruce and fir alone is desired, only these species need be tallied. For example, suppose a field survey on a black spruce cutover area disclosed 18 square feet of residual basal area per acre, of which 12 square feet is in spruce and fir. An estimate of volume 20 years hence is required. By interpolation from the first section of Table I a volume of 3.16 cords of spruce and fir and 3.64 cords of all species is secured. The table or charts can also be used to tell how many years must elapse before a volume sufficient to attract an operator can be obtained.

STAND COMPOSITION

The character of the stand after logging depends, for the most part, on the severity of the cutting and the former forest type. Stands that have been heavily cut over retrogress, that is, decline to a worse state. According to statistics released by the Forest Survey operating in the Lakes States, from 20 to 25 per cent of our original spruce–fir pulpwood area has been denuded by heavy cutting and fire. Those that have not been have suffered great losses in density and representation of the two main pulping species. On the other hand, it is evident from the plot data in this study that spruce and fir areas that have been cut over lightly or moderately are much more apt to maintain themselves against the intrusion of less valuable species and to grow at a faster rate.

Heavily cutover black spruce types are somewhat more liable to

become denuded than either of the others, chiefly because few species exist to take the place of the spruce. Difficulty in reclaiming a site from aggressive water-loving vegetation is another factor of importance. Areas that are not actually denuded, however, seem more inclined to return to spruce than to any other species. On only about 30 per cent of the plots did the composition change sufficiently to enable one to say that the type had really changed. Lack of competition from other tree species probably accounts for this "better than expected" showing. Those that did change turned principally to cedar and tamarack.

Cutover white spruce–balsam fir–paper birch types are less stable. They do not become denuded through cutting as easily as black spruce, because other species are always ready to take the place of the spruce and balsam fir that are removed, but they do burn over more frequently. Cutover areas that also burn over return to aspen almost without exception. Even in case the areas are not burned, aspen usually gains a strong foothold. Forty per cent or more of the plots measured showed aspen or some other aggressive hardwood taking over the site. On the wetter sites formerly occupied by this type white cedar furnishes the chief opposition to the return of spruce and fir. It definitely gained possession of about 20 per cent of the plots. From this condition there seems to be slight chance of early recovery, for, in view of the data gathered in the northern white cedar type, almost no kind or degree of cutting seems to favor spruce and fir.

GROWTH OF INDIVIDUAL SPECIES

Growth rates of individual species are valuable in determining silvicultural preferences and treatments. Figure 4 (p. 132) shows the D.B.H. growth of all the important species on spruce–fir cutover areas in northern Michigan. The curves originate from zero merely for purposes of comparison; actually all size classes were averaged to secure them. It is interesting to note that white spruce, a species widely recommended for planting, outgrows aspen over the course of forty years, despite the fact that several years are required to enlarge its crown before it can take full advantage of any release that may be provided, whereas the aspen gets an immediate start. Balsam fir likewise grows rapidly and, as shown by Figure 5 (p. 132), responds well when released from suppression. Hemlock, perhaps the third best pulping species after spruce and fir (although a wide gap sepa-

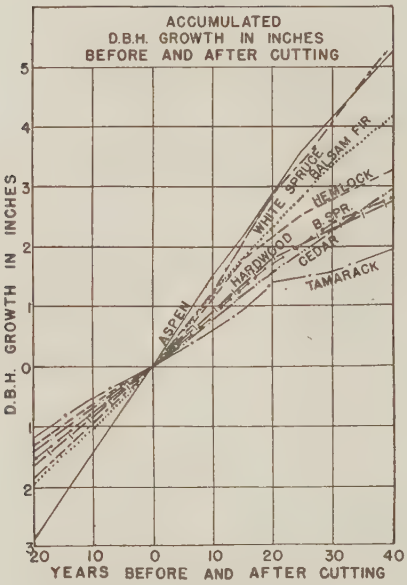


Fig. 4

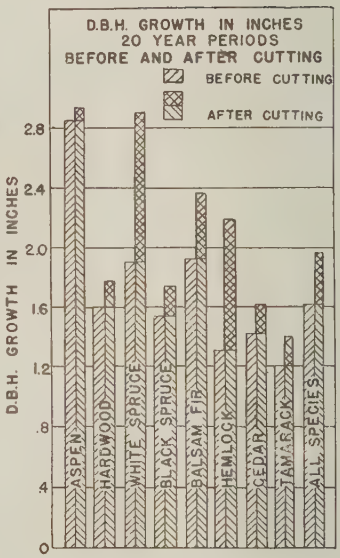


Fig. 5

rates them), also recovers very well from suppression, but seems incapable of maintaining the fast pace beyond fifteen years. Virtually all the other species exhibit small increases in diameter growth (see

TABLE II

Growth in Inches at D.B.H. in Twenty Years

Species	Growth before cutting	Growth after cutting	Response to release
White spruce	1.89	2.89	1.00
Black spruce	1.53	1.73	0.20
Balsam fir	1.93	2.38	0.45
Hemlock	1.30	2.19	0.89
Cedar	1.42	1.61	0.19
Tamarack	1.17	1.40	0.23
Aspen	2.84	2.93	0.09
Mixed hardwoods	1.60	1.76	0.16

Table II, p. 132), but they too soon revert to their normally slow pace. Since these growth rates are average for all site conditions and since the averages are strongly influenced by the preponderance of information acquired where the species is found most consistently, too much dependence should not be placed in them when one species is compared with another on the same site. Black spruce, for example, has sometimes shown the ability to keep up with balsam fir and white spruce when it occurs on good sites, but because it is usually found on poor sites its average is low. Before growth rates for each site quality can be determined, further work will be necessary.

SUMMARY

1. The most important factors affecting the volumes on cutover areas are residual basal area at the time of cutting, elapsed time after cutting, and site quality, which in this study was assumed to coincide with the former forest type.

2. Charts and tables have been prepared from the collected data to predict future volumes of cutover areas. A field survey to determine type, acreage, and residual basal area is a necessary preliminary.

3. Growth in merchantable volume averages for the black spruce type, 0.20 cord per acre per year; for the northern white cedar type, 0.45 cord; and for the white spruce–balsam fir–paper birch type, 0.55 cord.

4. Growth rates of spruce and fir compare favorably with those of associated species and show that, if these species are given a fair chance, they will maintain themselves against all opposition.

5. Heavy cutting is more inclined to cause changes in composition in the white spruce–balsam fir–paper birch type than in the black spruce type, although it is not so apt to denude the site.

6. Recovery of our cutover spruce–fir pulpwood lands depends on (*a*) the nucleus of spruce and fir left after logging, (*b*) the rates of growth of these and associated species, (*c*) the dominance of inferior species left after logging, and (*d*) the tendency of shrubs to monopolize the site.

Michigan State College
East Lansing, Michigan

THE USE OF LOG GRADES IN APPRAISING LUMBER VALUES OF SELECTIVELY CUT NORTHERN HARDWOOD TIMBER

WILLARD S. BROMLEY

THE use of log grades as a means of determining the relative quality of logs and trees was introduced into the region of the Great Lakes by the Lake States Forest Experiment Station at St. Paul, Minnesota, through its Forest Survey. The Survey log grades have also been employed as a device in appraising the value of selectively cut stands of hardwood timber. It is the purpose of this paper to describe and discuss the significance of a check on the use of these grades in appraisal work in northern hardwood forests. This objective is reached by:

1. Describing how the value of the lumber in six sets of logs was estimated by means of log grades.
2. Comparing these appraised values with the values calculated from tally of the lumber by lumber grades actually sawed from the same sets of logs in respect to: (*a*) the percentage of total lumber value removed by each of the six sets of logs by species; (*b*) the average value per thousand board feet of lumber from each group of logs by species.
3. Discussing the applicability of log grades to standing trees and selectively cut stands.

The field work was conducted on a tract of timber which was marked selectively with five different objectives and then clear-cut. Every log was graded and scaled. This field record formed the basis of six combinations (including clear-cutting) of logs in the same stand. Lumber values were appraised, and the results compared favorably with the values calculated from the lumber tally and grading of every board cut from the logs. Log grading produced more accurate appraisals of the values of different portions of the forest stand studied than could be made without grading.

I. THE APPLICATION OF THE LOG GRADES

Historical Background

In 1937 Henry G. White read before the Forestry Section of the Michigan Academy a paper [1] in which he pointed out that no accurate method of determining the value of selectively or partially cut hardwood stands in this region was available. He illustrated the difficulty of arriving at reasonable stumpage or lumber values for various forms of selective cutting in which the quality of the trees ranges from the best to the poorest. The log-grading system of the Forest Survey was suggested as a solution to the problem of measuring timber quality.

A subsequent logging and milling study conducted at Phelps, Wisconsin, by various branches of the United States Forest Service, proved that there were marked differences in values between the respective log grades. To determine whether the information furnished by the Phelps study would enable a forester to appraise to a reasonable degree of accuracy the value of lumber removed in partial cutting it would be necessary to grade a specific cut of logs and then check the value obtained by grading and appraising all the lumber cut from them. An opportunity to make such a check was presented by a marking and mill-scale study conducted by the Forest Service at Alberta, Michigan, on lands of the Ford Motor Company.

Field Work

On a 30.6-acre tract of northern hardwood timber west of Alberta two principles of marking selectively were tried, with two entirely different objectives:

1. The purpose of one method, referred to as "economic selection" because trees of the highest quality and greatest financial value are marked and cut first, is to produce the greatest net returns per thousand board feet or per acre *now*.

2. The goal of the other, called "silvicultural selection" since it requires the removal of the trees which are contributing the least to the general welfare and growth of the stand, is to obtain *in the*

[1] "An Introduction to the Study of Timber Quality in Lake States Hardwoods," *Pap. Mich. Acad. Sci., Arts, and Letters*, 23 (1937) : 339–348. 1938.

future the maximum net growth of forest products of the most valuable species adapted to the site.

With each objective three degrees of cutting were marked in the woods. All the living trees 11.0 inches in diameter and larger at breast height were designated for removal by recording the tree number in one of three categories, "cut," "leave," or "cull." After all the methods of marking had been completed on the same area, all the merchantable trees were felled. The tree number and the position of the log in the tree were recorded on each log. Then the logs were scaled and graded in the woods. An effort was made to disregard the condition of the ends of the logs during the grading, with the object of keeping the grading comparable in difficulty to the grading of the same logs in standing trees. The gross scale, net scale, grade, and other information about each log were all taken by the man who performed this part of the work.

The grades used at Alberta were based on those applied by the Forest Survey in the Lake States, as described by White in his article. It seemed necessary to depart from these grades in two details: (1) The use of an estimate of the percentage of No. 1 Common and better grades of lumber in the log was omitted entirely. (2) A set of equivalent values to convert various log defects to the "standard defect" of the Survey grades was added. These equivalents and other specifications of the grades used at Alberta are shown in Table I (p. 138).

After the logs had been scaled and graded in the woods they were hauled to the sawmill at Alberta, where each board sawed was numbered and graded by a licensed inspector of hardwood lumber. When the mill-scale study was completed the Forest Products Laboratory had a complete record of the number of board feet, by lumber grades, that were sawed from every log and tree in the tract. This information enabled the Laboratory to calculate the value of the lumber marked for cutting by each of the methods indicated in the woods. The preliminary results of this work were completed in the spring of 1939.

Appraisal of Lumber Values

Before these results were obtained the author had arrived at the lumber values by using the information developed for logs by grades in the study at Phelps, Wisconsin. This was done by:

1. Summarizing the net-scale volumes of logs by species, by log grades, and by the diameters of the small ends.

2. Converting the net-scale volumes to lumber tally by the use of overrun factors obtained in the Phelps study.

3. Multiplying the percentage of each lumber grade produced in the Phelps study by the current price per thousand board feet being paid for the lumber of different grades. This gave the average prices of the lumber cut from logs of specific sizes and grades.

4. Multiplying the average prices derived in item 3 for each of the sizes within a grade by the volumes obtained in item 2. The result gave the appraised value of the lumber which it was estimated would be cut from the logs selected by each method of marking.

TABLE I

Log Grades Used in the Alberta Mill-Scale Study

Grade	D.I.B. in inches	Length in feet	Standard defects *		Soundness percentage (based on regular scaling procedure)
			Defect	Equiv. diam. 1–3″ knots	
No. 1	12–14	12–16	1	3″	90
	15–17	12–16	2	6″	85
	18 up	12–16	3	9″	80
No. 2	10 †	10	1	3″	85
	10–11	12–16	2	6″	80
	12–14	12–16	3	9″	75
	15 up	12–16	4	12″	65
No. 3	10 †	10	No limitation set		50

* *Standard defects:* One knot 3 inches or more in diameter; or two knots 1 to 3 inches; or three knots $\frac{1}{8}$ to 1 inch. If a defect is similar to knots in its effect on lumber, conversion is made on the basis outlined.

Sweep and crook: Allowance is made by cutting down scale. Bad cracks and seams may be counted as defects and also scaled out.

Cracks, seams, or folds:

	STANDARD DEFECTS			
	1 face	*2 faces*	*3 faces*	*4 faces*
Full log length.....	1	2	3	4
One-half log length....	$\frac{1}{2}$	1	$1\frac{1}{2}$	2

† The minimum top D.I.B. and the minimum length of log vary with the standard of utilization practiced. The Forest Survey used 8 inches as a minimum top and 8 feet as a minimum length.

To follow this procedure every time an important change in lumber prices takes place would involve a tremendous amount of computing, one of the limitations of using log grades. Only the larger tracts of timber can be appraised in this manner if the cost of appraisal is to be kept within reasonable and practical limits.

II. COMPARISON OF RESULTS

When the appraised values obtained by applying the grades to the logs in the woods are compared with the values obtained by lumber grading at the mill, two significant questions are raised: (1) Did the log grades enable the appraiser to learn the relative value of different portions of the stand as marked? (2) Were the average values per thousand board feet of lumber derived from use of log grades within a reasonable degree of similarity to those obtained from the lumber tally?

In trying to answer the first question the author has reduced the total dry-lumber values to a percentage comparison, as shown in Table II:

TABLE II

COMPARISON OF THE PERCENTAGE OF VALUE REMOVED

Type of cut	Percentage of volume cut	Percentage of dry-lumber value cut					
		Sugar maple		Yellow birch		Elm	
		Log grades	Lumber tally	Log grades	Lumber tally	Log grades	Lumber tally
Clear-cut.....	100	100	100	100	100	100	100
Heavy economic..	39	55	53	60	59	11	10
Light economic...	29	42	42	46	44	9	9
Heavy silvicultural	79	77	75	68	67	96	95
Moderate silvicultural.....	54	46	44	53	51	65	65
Light silvicultural	20	16	14	22	23	20	20

In every method the log grades enable the writer to learn the relative proportion of total lumber value removed from the stand within 2 per cent of the value determined for the entire stand. This does demonstrate that the use of log grades will enable an appraiser to evaluate various cuts or portions of the same stand selected with a variety of objectives.

The second question relates to the practicability of an appraiser using log grades to determine the average lumber value of the various species in the stand within a satisfactory degree of accuracy. The results are given in Table III.

TABLE III

Comparison of Average Lumber Values

(On the basis of price scale used in Phelps study)

	Average value per M		
	Sugar maple	Yellow birch	Elm
A. Value per M appraised by use of log grades.....	$31.00	$33.90	$31.62
B. Value per M based on lumber tally of Forest Products Laboratory.....	26.97	33.44	32.33
Difference.....	+ $ 4.03	+ $ .46	− $ .71
Difference in percentage....	+ 14.9	+ 1.4	− 2.2

The results for yellow birch and elm are within a reasonable range of accuracy, but the value of sugar maple in the stand was overestimated. Since the proportion of large and high-grade sugar maple logs was as great as or greater than that given in the mill-scale study made at Phelps, the author is of the opinion that the discrepancy is due primarily to the presence of mineral stain in trees on the Alberta tract.

III. APPLICABILITY OF LOG GRADES TO STANDING TREES

This study has shown that the application of grades to logs before cutting gave reliable appraisals of lumber value, except for sugar maple. Since the grading was done under the assumption that the log was being graded in the standing tree, it might be concluded that satisfactory results would be obtained in applying the grades directly to standing trees. Such a conclusion is not entirely safe in view of the results of an attempt to do this in another phase of the mill-scale study at Alberta. It was found that most of the men, including the author, had a tendency to grade too high because of the extreme long-butting practices of the cutters and the difficulty of estimating where and how long the logs were to be cut.

As a final check on the usefulness of the Forest Survey log grades the appraised values were calculated without employing any grades. These results are based on average values per thousand board feet of lumber from trees in the Phelps study. A comparison of values obtained is shown in Table IV.

TABLE IV

Appraised Values with and without Grades

Species	Average value per thousand board feet		
	Appraised values		Actual value from lumber tally
	Without log grades	With log grades	
Sugar maple	$29.90	$31.00	$26.97
Yellow birch	34.60	33.90	31.62
Elm	31.40	31.62	32.33

The results obtained without grades are so close to those secured with grades that it does not seem worth while to apply them to the entire stand. In a comparison of the value of a portion of the stand with that of the entire stand, however, the log grades did produce results which were more accurate than those obtained when no grades were used. This is shown for the sugar maple trees by comparing the value per thousand board feet of the total stand with the values per thousand appraised for each of the five combinations of logs marked for selective cutting at Alberta (see Table V, p. 142).

In all five cuts the grading of logs permitted a closer estimate of the values of the trees removed than that obtained when grades were not used. This leads to the conclusion that log grades should be applied, but only to the trees removed or to the trees left. It should not be necessary to apply them to both portions of the stand unless the entire stand varies materially from the average in respect to the distribution of trees by species, size, and quality. The value of one portion valued with log grades subtracted from the value of the total stand appraised without grades gives the value of the remainder of the stand.

Although the results afford little information regarding the application of log grades to standing trees, the trends shown for logs may

TABLE V

AMOUNT BY WHICH AVERAGE VALUE OF SELECTIVE CUTS EXCEEDED AVERAGE VALUE OF TREES CLEAR-CUT

Type of cut (Sugar maple only)	Difference per thousand board feet		
	Appraised values		Actual value from lumber tally
	Without log grades	With log grades	
Economic selection:			
Heavy cut (39 %)....	$1.80	$4.30	$3.48
Light cut (29 %).....	3.10	4.98	4.39
Silvicultural selection:			
Heavy cut (79 %)....	2.30	1.90	2.01
Medium cut (54 %)..	1.50	.90	.44
Light cut (20 %).....	1.50	− .40	− 2.10

well be considered seriously. It is likely, then, that appraisals of trees to be cut will tend to overestimate values under silvicultural selection and to underestimate them under economic selection. If governmental agencies such as the United States Forest Service attempt to purchase the residual timber on private land which is to be selectively cut, the value of the trees marked for cutting will probably be appraised too high and that of the residual stand too low unless a measure of the difference in quality is obtained by use of log grades, tree grades, or other devices.

UNIVERSITY OF MICHIGAN

NATIONAL–FOREST LAND MANAGEMENT IN MICHIGAN

H. BASIL WALES

THE national-forest system is comparatively young, yet it constitutes one of the oldest continuous attempts at federal land management in the United States. It is true, of course, that other reservations have been made, but they have been almost entirely for "occupancy" use rather than for the management of the soil as a productive resource. The present paper deals with this latter aspect of federal control as it is manifested in the national forests of Michigan. It is not argued here that "occupancy" of land for specific purposes may not be good land management. In fact, good land-management practices must necessarily include withdrawal of certain areas of soil for higher uses than the production of crops.

The basic creative act, that of March 3, 1891, simply authorized the president "to set apart and reserve, in any state or territory having public lands bearing forests, in any part of the public land, wholly or in part covered with timber or undergrowth, whether of commercial value or not," certain areas as public reservations. The areas so set aside by presidential proclamation as forest reserves were just what the name signifies, "reservations," with but little authorization for administration and constructive land management. They were handled very largely on a custodial basis. By the Act of February 1, 1905, Congress transferred the administration of the forest reserves from the Secretary of the Interior to the Secretary of Agriculture. The name was changed from "forest reserves" to "national forests" to emphasize a new conception, that the forests were not "bottled up," but were for use by the people of the United States.

In his letter of February 1, 1905, to Gifford Pinchot, then head of the Forest Service, James Wilson, the Secretary of Agriculture, enjoined that the national forests be so administered as to result in "the greatest good to the greatest number in the long run." He also stated: "You will see to it that the wood, water and forage are pre-

served, and wisely used for the benefit of the home builder, first of all, upon whom depends the best and permanent use of land and resources alike. The continued prosperity of the agricultural and livestock interests is dependent upon a permanent accessible supply of wood, water and forage, as well as upon present and future use of these resources, under business-like regulations enforced with promptness, effectiveness and common sense."

Secretary Wilson recognized that the national-forest areas were more than just timber-producing areas. In the western states water was one of the most vital resources, and watershed values were not to be impaired. Forage also was an important asset. The use of forage was one of the items which influenced the change from "forest reserves," to be held for timber production and watershed protection, to "national forests," all the resources of which were to be open to use by the public under proper regulation. The forage crop was a resource, to be harvested by livestock and transmuted into meat and wool. It was likewise serviceable in holding soil in place, and was to be used wisely. Although he did not specifically include other resources in his letter to Mr. Pinchot, the implication was there. The national-forest areas embraced land suitable for agriculture or rich in minerals, and laws were passed whereby such land could be entered and developed by private enterprise. The importance of portions of the national forest for occupancy for uses which were legitimate and of value in community development or to an individual was apparent. Summer-home use was provided for. In other words, there was early recognition that the national forests not only were for timber production on a continuous basis and for stream-flow regulation, but might also be utilized, at the same time, for many and varied purposes without detriment to the primary one for which they were reserved. Secretary Wilson instructed that they be managed for "the greatest good to the greatest number in the long run."

To this varied use of the forest the term "multiple use" has been given in recent years. To some extent the term is a misnomer, for it does not mean that every acre of national-forest land should be used in a multiplicity of ways; it should be applied to the land area as a whole. "Multiple use" refers to the utilization of all of the land-resource values — as opposed to single-purpose management. Some portions of a national forest may be employed for several purposes

at one and the same time without serious detriment to the primary one. On many forests grazing is compatible with timber production. On others, particularly the hardwood ones of the East, it is incompatible, at least in any degree of intensity. Timber can be grown and harvested, and at the same time the forest can be the home of game and other forms of wildlife. Silvicultural methods may have to be modified somewhat in favor of special requirements of wildlife, but as a matter of fact the harvesting of timber on a progressive basis improves conditions for many of the game species which inhabit the forest.

Harvesting the timber crop, especially on a partial or a selective cutting basis, is not necessarily incompatible with the recreational use of the forest. With the cutting of low stumps, and careful attention to utilization and slash disposal, the average recreation seeker will hardly miss the few trees taken out of the stands. On certain areas, such as those along streams, on lake fronts, and in roadside zones, recreational use and the necessity of maintaining aesthetic values may require the giving of the area a dominant classification for that purpose, and the subordinating of timber production and forage utilization. But even here the trees must be kept in a thrifty growing condition. When a tree has served its purpose in a stand good conservation demands that it be cut and utilized. Provision must be made for the gradual replacement of veterans with younger, thrifty trees, but it must be done in such a way, if at all possible, as not to leave unsightly scars. The transition should be undiscernible except to the most discriminating eye.

There may be areas which should be managed for some major purpose other than timber production or recreation. Watershed protection must inevitably be a dominant classification wherever soil, slope, or special condition is such as to require it. The necessity of preventing destructive erosion, either by wind or water, is paramount in connection with each and every use of the forest.

Although the Secretary particularly emphasized assistance to the home builder, still it must be remembered that the national forests are the property of the entire nation. Hence they must serve the general public as well as the individual settler or home builder who may live within or near them. Their interests must be carefully correlated. Land-use planning is a prerequisite to land management. Planning the use of a small tract in private ownership may be a

relatively simple matter or it may be somewhat complicated. A level tract of rich, fertile soil may at once be definitely planned for permanent agricultural use and, so far as an individual owner is concerned, may be managed on this basis. But if the land is within a valuable reservoir area, it may have a higher value for water power or flood protection. Again, an owner may decide that it can be used for agriculture and at the same time produce a valuable crop of upland game birds or small game animals. It may be so located as to have a higher value for recreation purposes, perhaps a golf course. If it should be somewhat steep or rolling, then the best use may be a combination of agriculture, permanent pasture, and forest.

If the determination of the best use of a small area is difficult, then obviously the planning of proper land use on a national-forest area of approximately a million acres will require detailed study. Particularly is this true when one considers the many and varied interests of the owners of the national forests. One hundred and thirty million people have a general interest in the cash returns and the benefits which can be secured on a broad public basis. A few million people in an individual state, and a still smaller number in a county or a community, have a more direct interest. Finally, the settlers within or near a forest are greatly concerned, for their use of the forest resources may result in a supplemental income sufficient to make possible a reasonable American standard of living.

The national forests were at first very largely in the West. The forested land in the East had practically all passed to private ownership, and had been more or less destructively logged. The only areas of public domain in the East of sufficient size to warrant reserving as national forests were in Florida, Arkansas, Minnesota, and Michigan. Here in the north-central region a portion of the present Superior National Forest in Minnesota and some relatively small areas in what is now the Huron and the Marquette National Forests in Michigan were set aside from the public domain. The Weeks Law, passed by Congress in 1911, authorized the purchase of land by the federal government on the headwaters of streams. An amendment to this law, passed in 1922, authorized the purchase of land for timber production, as well as for watershed protection.

After the Michigan State Legislature had passed an enabling act five national-forest purchase units were set up. They have since been proclaimed national forests. The gross area within the national-forest

boundaries in Michigan amounts to 5,095,121 acres. It is estimated that approximately 785,000 acres will be nonpurchasable, and will, therefore, remain in private ownership. The ultimate area which it is expected will be acquired for national forests is 4,310,000 acres. One million eight hundred and eighty-one thousand acres have already been purchased or are well along in the process of title transfer. The purchasing is, therefore, 43.6 per cent complete.

As before indicated, these areas are now under management as national forests. There are, however, only four administrative units; the Hiawatha and the Marquette National Forests have been combined for administration under one forest supervisor.

The establishment of a national forest or of a national-forest purchase unit is one phase of land-use classification. The basic creative act of 1891 and the Weeks Law, as amended, both require that the land be "chiefly valuable for timber production or watershed protection." An examination of the areas to determine general adherence to this is a prerequisite to establishment. Boundary lines are drawn to include major areas of forest soil and to exclude areas primarily valuable for other purposes, and at the same time to define logical administrative units.

The Manistee National Forest, for example, stands on two legs, astride an area of good soil around Fremont and Newaygo, which, with proper adjustment of farm practice, will probably be suitable for permanent agricultural use. The west line of the forest follows closely the east side of a highly valuable fruit and resort country. The east boundary marks the approximate line between forest soil and soil just a little better which has been partially developed for agriculture. There was no definite reason for stopping on the north end except that there are some farms in the Mesick and Kaleva territory and that it is only a relatively short distance to the Fife Lake State Forest. It should be mentioned that the east line originally included most of what is now the Baldwin State Game Refuge; but when the State Conservation Department signified its desire to give that area a high value for wildlife purposes, the national-forest line was pushed back to the west.

An examination of any one of the five national-forest areas in the state will show that by and large the boundaries are logical and that the national-forest area includes, in major portion, land which is "chiefly valuable for timber production and watershed protection."

With the possible exception of the west end of the Ottawa, the national-forest areas were real problem areas, areas "out of production," which should be restored and rehabilitated in order that they might become an asset rather than remain a liability. The western portion of the Ottawa was included in the national-forest purchase unit in the hope that some arrangement might be made whereby the large acreage of virgin timber would remain fully productive and not be devastated by a continuation of destructive logging practice.

The purchase of nearly 50 per cent of the area set up for acquisition does not finish the task of use classification. The Forest Service recognizes that forest land management is not just timber production and watershed protection. There are many other values inherent in a forest area to be protected and enhanced. All the resources are to be used and enjoyed.

In any area of a million acres it is inevitable that considerable good soil will be included within the exterior boundaries — good soil for the growth of exceptionally fine timber, but likewise valuable for the production of agricultural crops. The federal government does not desire to purchase such areas of good farm soil, except as they may be small and more or less isolated. The cost to local government of constructing and maintaining roads and keeping them open during the winter, and of furnishing school facilities to settlers on such tracts, justifies retirement from agricultural use.

Thirty-five years ago the Secretary of Agriculture instructed that the forest be managed for the home builder first of all. This is still one of the primary objectives of national-forest land management. Areas of good soil are set up for community development. Where land is acquired within such an agricultural community, it is used either for exchange or under special-use permits for agriculture or for pasture, so that the agricultural community is strengthened. An endeavor is made to have each farm unit within such an area self-supporting. The farmer may need additional cropland, but it has been found that he is mostly in need of summer pasture. Suitable pasture areas are provided to the fullest possible extent.

The forests of Michigan are accessible to areas supporting a large industrial population. They are within two or three days' drive for one quarter of the people of the United States. Obviously, these areas have a very high recreational value. Trees and water are basic requirements for this use. The regular timber-production practices

provide timber and help to protect water. If forest areas are to serve the highest public recreational value, access to water is important, and the acquisition program definitely contemplates the purchase of some lake and stream frontage. The recreational policy gives use by the general public precedence over the more exclusive semipublic or individual use. Picnic grounds and camp grounds are developed for the convenience of the public, and only after the full needs, so far as they can be foreseen in the future, have been provided for will land be classified for summer homes or resorts. Moreover, there appear to be plenty of summer-home and resort sites available on privately owned land. These areas should remain on the tax roll. The summer visitor is provided for, and areas are also being developed for winter use. Within the five national forests in the state of Michigan fifteen picnic grounds, twenty camp grounds, thirty-six combined picnic and camp grounds, and two winter-sports areas have already been developed.

The wildlife resource on the national forest is given recognition both as a crop to be harvested and in its relation to recreation. Action by the Forest Service is primarily one of the manipulation of environment so as to bring about suitable conditions for the wildlife species. The harvesting of the crop is controlled by the state under state laws and regulations. Winter deeryards which have been purchased are given a dominant classification for that particular use, with timber in a minor status, to be harvested only after the browse becomes unavailable as deer food. The problem of management of deeryards has not yet been solved. Natural regeneration of cedar stands is relatively easy to secure, under a proper degree of protection, but the yards cannot be reproduced if they are used excessively by deer. Not much has yet been done in the matter of game-food planting. However, the Forest Service is going ahead with this in an exploratory way. Areas which are valuable as waterfowl nesting or resting grounds are set aside for this purpose, and water levels are being restored and maintained by the construction of small dams. The entire national forest is considered available as public shooting grounds, except small areas which may be designated by the state for game refuges or sanctuaries. Streams and lakes are being surveyed, and stream improvement work is being done in full coöperation with the State Conservation Department and the Fisheries Institute. In the national forests of Michigan fish are reared in two rearing ponds,

and 19 million fry, 412,000 fingerlings and 18,000 yearlings were planted in 1939 coöperatively.

In the use classification of the land for management purposes special tracts such as wildernesses, natural areas, experimental forests, etc., are designated, and even a wild-flower sanctuary is now under consideration on the Manistee National Forest. In these specific regions timber production is definitely subordinated.

Of course, the primary purpose of the national forest for timber production or watershed protection cannot be overlooked. The Forest Service believes — and, I think, rightly — that timber production, including the harvesting of the crop, can be carried on over most of the national forest area to the benefit of the local people and industry without seriously reducing the highly valuable recreational and wildlife resources. One of the objectives of the Forest Service is to improve the status of the people within or near the forest, and to stabilize communities and industries. The forests are vast reservoirs of work, in the accomplishment of which many people will secure a supplemental cash income, which will mean the difference between poverty and a comfortable living. The harvesting of timber and the fabrication of timber products will provide a part of that income, and as the forest matures the amount of such work will materially increase and thus obviate the necessity of huge relief appropriations.

In the first six months of the present fiscal year 10,503,000 feet BM of timber, having a stumpage value of $21,769.39, were sold from the national forests of Michigan. Figured at the rate of three man days per thousand board feet, this sale of stumpage will provide 31,500 man days of work. It will mean steady labor for over 100 men for a full year, or part-time employment for a three months' period for 400 men. It is admittedly not a large figure, but when one considers the present status of the national-forest timber crop it is indicative of the large employment which will be possible when the national forests are in full production.

The trees which have been sold have served their purpose in the stand. Their cutting will be simply a salvage of wood products, and will in no way deplete the growing stock of the forest. It is simply good conservation to harvest the crop. Recreational and scenic values will not be destroyed and, if what experts tell me is true, wildlife habitat will be improved.

The national-forest units in Michigan are problem areas. They have been cut over and burned over to such an extent that they are no longer fully productive of timber. The Forest Service has been accused of buying the "worst first," yet approximately 75 per cent of the national-forest land is stocked with timber sufficient to give promise of a merchantable crop in the near future. Only about 25 per cent has been devastated to such an extent as to require planting before it will become really productive of timber values. Good land management requires that this nonproductive area become productive. The reëstablishment of a forest growth will result in greatly improved recreational and scenic values. Wildlife experts object to continuous stands of conifer plantations, stating that such areas become "biological deserts." This might be true *if* such plantings were made and *if* an exceptionally good survival of the planted trees were secured. A recent careful analysis of a relatively large area bearing a highly successful twenty-year-old plantation did not support their viewpoint. There were still plenty of openings and edges, and an admixture of species. Moreover, there was game food available, and the area was used by deer and other animals; this wildlife, although not quite so abundant as on adjoining unplanted ground, nevertheless constituted reasonably satisfactory stocking.

In this particular plantation all the overtopping oak was cut out of the stand in 1933 to release the planted trees. This was a mistake, for retention of white oak would have furnished a desirable mast crop as fall and winter food for deer. Sprout growth is replacing the oak which was cut. Part of it should be retained. Opinions differ as to what the future twenty, forty, or even eighty years hence will hold. Will the crowns close up all the openings? I doubt it, even though no intermediate cuttings be made. I anticipate that such cuttings will be made, and that they will admit light for ground vegetation.

This finding of fact is not an argument for the reëstablishment of a forest in large continuous blocks of a single species. Our maps may show as much as 10,000 acres included in a planting area, but I am sure a careful examination on the ground will reveal a variety of types and species, openings and edges, highlands and lowlands, swamp areas and well-drained areas. When the planting job is planned, wildlife requirements are taken into consideration, not on a maximum basis, but on a favorable one. An effort is made to correlate all the interdependent resource values.

A recent publication, *Our Use of the Land*,[1] by Ayres Brinser, with the assistance of Ward Shepard, points to the Forest Service as an outstanding example of single-resource management. This would be true if the national forest were managed only for timber production. National-forest land management aims to capitalize all the resource values inherent in the land within a national forest and to correlate these resources one with the other and on the basis of harvesting the crops without depletion.

Forest Service
United States Department of Agriculture
Milwaukee, Wisconsin

[1] New York: Harper & Bros., 1939.

THE GROWTH AND DEVELOPMENT OF A MIXED-CONIFER PLANTATION

LEIGH J. YOUNG

SUCCESS in forest planting depends in large measure upon a number of fundamental factors, such as proper choice of species, use of the right kind of stock and planting methods, adequate protection of planted area, correct spacing of trees, and, in the case of mixtures, suitable arrangement of species with respect to one another. A good deal of help in arriving at more accurate decisions concerning these factors can be secured from studies of previous planting projects, whether successes or failures. Such a study of one of the oldest forest plantations in Michigan was initiated in August, 1933, under the direction of Professor W. F. Ramsdell of the George Willis Pack Forestry Foundation.

This plantation is a stripwise mixture of five coniferous species that was established in the spring of 1903 upon a 35-acre tract of land owned by the Cleveland Cliffs Iron Company and located about three and one-half miles northeast of the City of Negaunee.

The soil of the area is a light glacial outwash sand, which was covered at the time of planting with a dense growth of grass. That white pine was present in the original forest was indicated by the remains of a number of large stumps of that species. There was no evidence on which to base a determination of the species that were associated with the white pine in the old stand. Prior to planting the tract had been cut over and subsequently burned.

Preparation for planting consisted in plowing rather narrow deep furrows at intervals of about 6 feet to remove the cover of grass. The trees were planted in the furrows, about 6 feet apart. According to the record of the Company, the stock used was as follows:

5,000 Scotch pine, 3 years old
1,000 Scotch pine, 6 years old
12,000 white pine, 3 years old
1,000 red pine, 3 years old
20,000 Norway spruce, 3 years old

This record is incomplete, however, since one strip was planted with Douglas fir, and trees of this species were also mixed irregularly with Norway spruce, white pine, and Scotch pine along the west edge of the plantation.

With one exception the different species were planted in pure strips, running in a north–south direction and varying in width and arrangement. The exception was a strip on which white pine and Norway spruce were mixed. The width of the strips ranged from 5.4 feet to 44.3 feet.

In August, 1933, a permanent sample plot was established in this plantation, one chain in width and extending completely across the area in an east–west direction, so that it crossed all the strips at right angles. At this time all the live trees on the plot were numbered and measured, and a very light thinning was made in the Scotch and red pines. A considerable number of aspen and cherry were cut wherever they were interfering with the growth of the conifers. Thinning was extended to a distance of one-half chain on both sides of the plot to provide isolation. Prior to this time no growth measurements had been made, nor had any cultural operations been performed.

The total area of the plot is 1.875 acres, and the area planted with each of the several species on the plot is as follows:

Norway spruce.....	0.9658 acre
White pine.....	0.6246 acre
Scotch pine.....	0.2220 acre
Red pine.....	0.0380 acre
Douglas fir.....	0.0246 acre

Comparative growth figures for the four major species are given in Table I. In computing means it was assumed that the measurable growth for 1933 had been completed, so that the age since planting was taken as 31 years.

In calculating the basal area per acre, the volume per acre, and the mean annual volume growth per acre the areas used were those occupied by each species at the time of planting. As the result of a more rapid early height growth the Scotch and red pines overtopped and suppressed the spruces on adjacent strips and so secured a greater amount of growing space for the trees in the outside rows of each strip than they would have had otherwise. To obtain figures that would represent more accurately the relative productiveness per acre the areas of the strips of Scotch and red pines should include the en-

TABLE I

GROWTH FROM 1903 TO 1933, INCLUSIVE

	Species			
	Norway spruce	White pine	Scotch pine	Red pine
Average diameter breast high in inches..	4.0	5.3	7.8	6.7
Maximum diameter breast high in inches	8.7	10.1	11.8	8.7
Minimum diameter breast high in inches	0.0	1.0	2.5	3.6
Maximum total height in feet.....	35.6	31.7	43.6	41.9
Average total height in feet.....	22.0	19.3	33.7	35.5
Total basal area on plot in square feet..	90.144	62.382	54.966	13.137
Basal area per acre in square feet.....	93.336	99.875	247.594	345.71
Total volume in cubic feet.....	991.58	421.39	740.94	233.18
Volume per acre in cubic feet.....	1,026.69	674.65	3,337.56	6,136.31
Mean annual diameter growth in inches.	0.129	0.171	0.251	0.216
Mean annual height growth in feet.....	0.71	0.62	1.09	1.14
Mean annual volume growth per acre in cubic feet.....	33.12	21.76	107.66	197.94

tire growing space of the crowns, and those of the strips of Norway spruce should be limited to the portions on which the spruce has been free from interference by the pines. Revision on this basis would lower the values given for Scotch and red pines and increase those for Norway spruce. Because of the narrowness of most of the strips the effects of the differences in growth of the trees on their edges are considerable.

The few trees remaining on the strip planted with Douglas fir were so badly suppressed and deformed that no measurements of them were taken. On the west edge of the plantation, however, 47 trees that had not been overtopped were measured in 1934 and showed growth as follows:

Maximum height.....	35.0 feet
Minimum height.....	14.0 feet
Average height	23.0 feet
Maximum D.B.H.....	7.3 inches
Minimum D.B.H.....	2.1 inches
Average D.B.H.	4.1 inches

This corresponds closely to the growth made by Norway spruce.

The placing of strips of species of rapid early height growth adjacent to those of much slower growth has resulted in poor natural

pruning on a large percentage of the trees in the stand. The crowns of the Scotch pine are particularly wide, with branches of large diameter, as shown in Plate I. The value of the Scotch pine has been lowered still further by crookedness of bole, a condition that occurs in almost all the trees in varying degrees and is probably due to seed from a poor source. In the white pine height growth has been stunted and normal form destroyed by repeated attacks of the tip weevil. Red pine and Norway spruce have excellent form, except for limbiness. Plate II shows some of the red pine, as it appeared in 1938 after being pruned to a height of 17 feet. The condition of these trees in 1933, before pruning, is illustrated in Plate III.

In August, 1938, all trees on the plot were remeasured and additional thinning was done. The conditions as shown by the measurements are given in Table II.

TABLE II

Condition of Stand in 1938 before Thinning

	Species				Plot totals
	Norway spruce	White pine	Scotch pine	Red pine	
Average diameter breast high in inches	4.5	5.9	8.7	7.7	..
Maximum diameter breast high in inches	10.1	10.9	12.9	9.5	..
Minimum diameter breast high in inches	0.0	1.5	4.0	5.5	..
Average total height in feet	24.4	21.2	36.3	43.5	..
Maximum total height in feet	44.3	34.4	48.7	45.7	..
Total basal area in square feet	122.972	69.496	54.674	14.872	262.014
Total volume in cubic feet	1,500.25	736.65	992.33	279.59	3,508.82

The average basal area and the volume per acre for the plot in 1938 were 139.741 square feet and 1,866.03 cubic feet, respectively. This volume represents a mean annual growth of 52 cubic feet per acre for the entire plot since the year of planting.

The growth made by the four principal species during the five-year period between measurements is shown in Table III. Average diameter growth of the Douglas fir for the period 1934 to 1938 was 0.4 inch, and average height increased 6.3 feet.

In 1926 the survival was estimated by one of the cruisers of the

TABLE III

Growth from 1933 to 1938

	Species				Plot totals
	Norway spruce	White pine	Scotch pine	Red pine	
Average diameter breast high in inches	0.5	0.6	0.7	0.8	..
Total basal area in square feet	32.828	7.114	6.227	2.338	48.507
Average total height in feet	2.4	1.9	2.6	8.0	..
Total volume in cubic feet	508.67	315.26	251.39	46.41	1,121.73
Average basal area per acre	..	..	..	..	25.861
Average volume per acre	..	..	..	..	598.25

Company at 90 per cent for Scotch pine and Norway spruce, 80 per cent for red pine, and 65 per cent for white pine. The actual stocking of the plot in terms of number of trees per acre in 1933, before any thinning was done, and in 1938, after the thinning of that year, is shown in Table IV.

TABLE IV

Stocking of Plot in Terms of Number of Trees per Acre

Species	*1933*	*1938*
Norway spruce	1,245	1,077
White pine	653	562
Scotch pine	621	549
Red pine	1,262	973

The apparently heavy stocking of the strips of Norway spruce is due to the presence of many small, oppressed trees that are not worth removing in thinning. The abnormally heavy stocking of red pine consists almost entirely of dominant and codominant trees and is possible only because of the unrestricted growing space along the outside edges of the strips. As the trees in the central portion of the spruce strips broaden their crowns this unrestricted growing space will be reduced, better natural pruning of the pine will result, and heavier thinning will become necessary.

A number of important conclusions may be drawn from this study:

1. A stripwise mixture in forest planting is inadvisable unless the species on adjacent strips have very similar rates of height growth on

that particular site. The ill effects of a serious disparity in rates of height growth are greater on narrow strips.

2. This form of mixture has not prevented heavy damage to white pine by the tip weevil.

3. Under present conditions the planting of white pine in stands in this locality will not be profitable.

4. If Scotch pine is to be planted, proper care must be exercised to insure that seed is from a suitable source.

5. The exotic, Norway spruce, has made satisfactory growth on the whole, except on areas dominated by pine, and has been free from any appreciable damage.

6. Red pine has excelled the other species in every respect.

7. The stock and planting method used resulted in adequate stocking, except in the case of white pine.

8. In terms of volume alone, i.e. disregarding quality, the production of wood has been good, since the average for the entire plot during the last five years has been 1.196 cords per acre per year on the basis of 100 cubic feet of wood per standard stacked cord.

University of Michigan

Wide crowns of Scotch pine and suppressed Norway spruce in adjacent rows

Red pine in 1938 after pruning

Red pine in 1933 before pruning. Photograph taken from same point as that shown in Plate II